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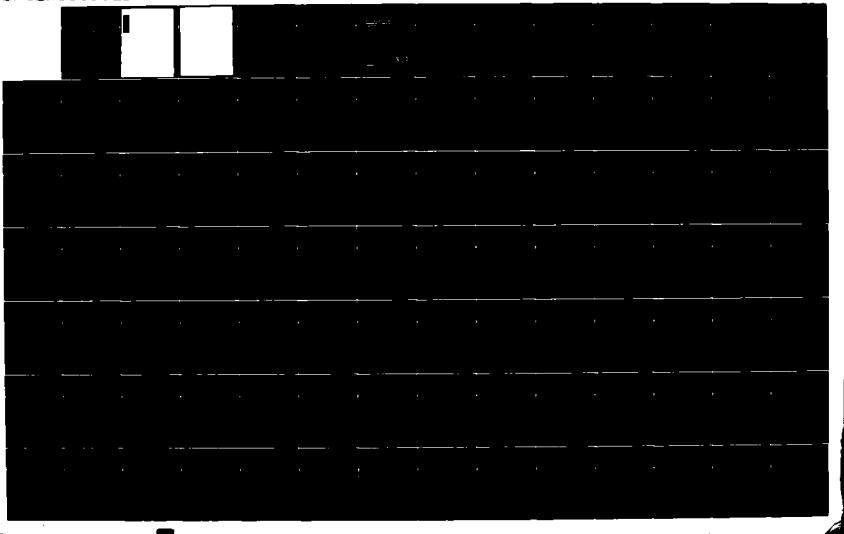

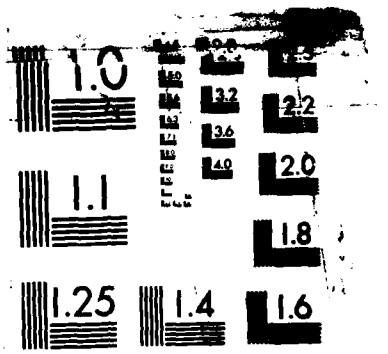

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This report documents a project to investigate alternative ways of bridging important differences between the Air Force Medical Service's peacetime and wartime missions. It uses information from a Rand survey of Air Force physicians' wartime skills and a mathematical programming model. It summarizes the model, documents the results of the skill survey, describes criteria for joint-mission medical manpower planning, and uses the model to analyze the effect of wartime cross-specialty substitution and peacetime resource constraints on physician capability. Among the conclusions suggested by the research are the following: (1) a wartime substitution policy based on the current tri-service substitution list could substantially improve wartime capability; (2) additional improvements would result if the tri-service list were revised in accordance with survey results; and (3) well-designed substitution roles for nonsurgeons can free surgeons to spend most of their time in surgery.

R-3202-AF

Reconciling Air Force Physicians' Peacetime and Wartime Capabilities

Demonstration of a Workforce Design Methodology

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PREFACE

This report documents a project, sponsored by the Air Force Surgeon General, that has investigated alternative ways of bridging important differences between the Air Force Medical Service's peacetime and wartime missions. The research uses information from a Rand survey of Air Force physicians' wartime skills and a mathematical programming model that was described earlier in N-1990-AF, *A Methodology for Evaluating Air Force Physicians' Peacetime and Wartime Capabilities*, J. L. Buchanan and S. D. Hosek, July 1983. This report summarizes the model, documents the results of the skill survey, describes criteria for joint-mission medical manpower planning, and uses the model to analyze the effect wartime cross-specialty substitution and peacetime resource constraints have on physician capability.

The Rand research project, entitled "Air Force Medical Resource Planning," was conducted under the Project AIR FORCE Resource Management Program. The project also analysed physician accessions and retention in the Air Force and estimated the costs of alternative physician procurement programs. Other project publications are:

N-1924-AF, *Israeli Military Medical Experience: Ideas for the U.S. Air Force's Medical Service?* G. A. Goldberg, August 1982.

N-1968-AF, *Procurement of Air Force Physicians: Scholarship or Direct Recruiting?* S. D. Hosek, July 1983.

R-3185-AF, *Retention of Volunteer Physicians in the U.S. Air Force*, V. Daubert, February 1985.

SUMMARY

The Air Force Medical Service serves two purposes: maintaining a deployable wartime medical system and providing peacetime health care to active duty personnel and other military beneficiaries. These two purposes require considerably different mixes of physician skills. Historically, the mix of physician skills in the peacetime workforce has been largely determined by the peacetime workload and wartime planning assumed that this workforce could be augmented by civilian physicians. **Concerned that large-scale conflicts could arise without sufficient warning to mobilize civilians, the Air Force now plans to staff overseas wartime medical units initially primarily with active duty physicians.**

The research described in this report was an initial attempt to investigate alternative ways of bridging the difference between the Air Force Medical Service's peacetime and wartime manpower requirements. Results of the study indicate a need to further develop and define this issue. The study developed a methodology for assessing physician substitution in wartime and evaluating the feasibility of maintaining a capable wartime system during peacetime. The methodology includes two components:

- A survey of Air Force physicians to determine their skills in wartime medicine and identify candidate wartime substitutions
- A workforce design model to select from the list of candidate substitutions those that are most valuable and to assess the physician workforce's capability to provide needed wartime medical care under various peacetime constraints

The workforce design methodology complements a family of provider manpower planning models, called PRISM, developed by the Air Force to estimate the number of physicians and nonphysician providers required to optimally satisfy peacetime and wartime workload demands.

The report describes the survey and interprets its results, explains how the workforce design model uses information on Air Force medical priorities to assign physicians in different specialties to productive wartime roles, and describes our efforts to develop data inputs for the model. It illustrates how the model can suggest and evaluate alternative policies for reconciling differences in peacetime and wartime physician requirements.

The expected wartime surgical case load requires approximately 2125 active duty surgeons, including subspecialties except for obstetrician/gynecologists, but the peacetime beneficiaries served by Air Force hospitals and clinics could keep only 900 surgeons busy. The Air Force actually had 450 fully trained surgeons on active duty at the end of FY1983—20 percent of its wartime requirement. The active duty workforce included around 1500 physicians and physician assistants in internal medicine, pediatrics, family practice, and obstetrics/gynecology with poorly defined wartime roles. **If "peacetime" specialists could relieve the inadequate surgical staff of some of its simpler wartime tasks, the surgeons could be used where they are most needed.**

The survey posed a series of questions about the respondent physician's training and professional experience and then asked him to self-assess his ability to perform a list of specific wartime tasks, including a wide range of tasks outside his specialty. The task list varied somewhat for different specialties. We fielded the survey in six specialties: family and general practice, internal medicine, pediatrics, emergency medicine, obstetrics and gynecology, and general

surgery. Three-quarters of the 1120 physicians in the sample returned completed questionnaires.

The survey results support the following conclusions:

- **Despite the absence of routine peacetime practice, the general surgeons reported themselves able to perform all the wartime abdominal and thoracic surgical procedures listed in their questionnaire, as well as amputations.**
- **The general surgeons could substitute for other surgical specialists in numerous tasks, but would need some training to adequately perform these tasks.**
- **By contrast, the obstetricians and gynecologists believe they can carry out only general surgical tasks; their hesitancy regarding specific surgical tasks suggests the Air Force should proceed cautiously with plans to substitute Ob-Gyn specialists for other surgical specialists.**
- **Family and general practitioners, internists, and pediatricians could fill some vital wartime roles with a modest investment in training.** Physicians in these specialties report they can perform tasks necessary for basic resuscitation and even some minor surgical procedures. They can also carry out local or area anesthesia and pre-operative and post-operative fluid and infection management.
- **The family practitioners' broader training does not appear to prepare them to perform any but minimal surgery.** With some training, this group could take on some orthopedic tasks and general surgical tasks such as delayed primary closure.
- **The emergency medicine physicians report an ability to perform a broad range of important wartime tasks, including surgical specialty exams. However, the peacetime workload does not permit the Air Force to support many of these specialists.**

Physicians who had actual trauma experience reported themselves more capable at performing most wartime tasks. The effect of the military wartime medicine courses was similarly positive, but smaller. In the future, these courses could more productively focus on more specific training for each specialty. In addition, the Air Force might review its residency training curricula in surgical specialties in light of the broad surgical skills needed in wartime.

The survey results suggest some changes in a current tri-service wartime substitution list. The general surgeons and obstetrician/gynecologists felt incompetent at some more specialized surgical procedures for which they are currently listed as substitutes but expressed greater confidence in their ability to perform other more general tasks not in the tri-service list. The peacetime medical specialists in internal medicine and pediatrics believe they could relieve surgeons of some pre-operative and post-operative care and perform other basic wartime tasks.

In illustrative applications of the workforce design model, we selected the most useful of the potential substitutions suggested by the survey results. The model results also provide meaningful measures of the physicians' wartime capability under different policies regarding specialty substitution and different constraints on available physician manpower. The capability measures reflect the extent to which the wartime workload could be accomplished and desirable patient outcomes could be realized. The results depend on the validity of the values we used for some important model parameters that could not be estimated from existing data. However, these applications of the workforce design model do strongly suggest the following conclusions.

- **A wartime substitution policy based on the current tri-service substitution list could substantially improve wartime capability. Our results show a 50 percent increase in both capability measures.**
- **Additional improvements (of 20–30 percent) would result if the tri-service list were revised in accordance with the survey results.**
- **The revised substitution list also permits the design of substitution roles for peacetime specialists such as internists, pediatricians, and obstetrician/-gynecologists that better match their skills.** Therefore, less effort would be needed to train these physicians in the substitute skills.
- **Well-designed substitution roles for nonsurgeons can free surgeons to spend almost all of their time in surgery.**
- **Current authorizations levels for physicians, together with supply constraints in surgical specialties, do decrease wartime capability and imply a need for reserve surgeons who can be mobilized immediately.** However, expanding the Air Force Medical Service to the limits set by the availability of peacetime patients would probably not fully eliminate this need for reserve surgeons.
- **Like any other group of patients, retired family members play an important role in maintaining active duty physicians' wartime capability by supplying peacetime work.**

ACKNOWLEDGMENTS

We wish to express our appreciation to Lt. Col. Thomas Schumann and Lt. Col. Stephen Jones, who served in the Surgeon General's Office during the course of this project. Their explanations of the Air Force's wartime medical system and support for the project greatly facilitated the research. We are also grateful for the time and thoughful comments provided by the physicians we interviewed during the course of our research. Lt. Col. William Tufte provided essential information on peacetime manpower requirements and on the PRISM III model. The Combat Development Center at the U.S. Army's Academy of Health Sciences generously supplied us with copies of their data sets and wartime models. We extend special thanks to Lt. Col. Frank Holub, who as project officer assisted us in many ways.

We are grateful to a former Rand colleague, Brian Leverich, for supplying the network code that forms the analytic core of the workforce design model. Jane Peterson provided able programming assistance to the project. Finally, we received useful comments on earlier versions of this report from Nicole Lurie and Richard Neu.

The report has benefitted from the contributions of these people. However, we remain responsible for the conduct and findings of the research documented here.

CONTENTS

Appendix

Table 4

RESPONSE FREQUENCIES: OBSTETRICS AND GYNECOLOGY
(Percent of respondents)

Task	Now	With Practice	With Training				
			1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Intubation of airway	61	35	1	0	2	1	0
Tracheostomy	11	60	20	4	4	0	1
Cardiocentesis and pericardio	11	42	28	9	6	1	2
Assess fluid,electrolyte reqs	80	8	9	2	1	0	0
Insert central venous line	50	38	8	0	4	0	0
Interpret EKG	23	19	27	19	9	4	0
Interpret X-rays	48	17	14	11	9	0	2
Perform (specialist) ent exam	9	16	17	24	16	10	8
Perform (spec) orthopedic exam	7	8	15	25	21	16	7
Perf (spec) neurosurgical exam	4	10	20	21	20	13	12
Perform lumbar puncture	80	18	1	0	0	1	0
Admin core rewarming procedure	2	33	39	12	9	2	3
Admin local/area anesthesia	89	8	2	1	0	0	0
Maj debridemnt-req gen anesth	54	28	9	5	2	0	2
Delayed primary closure	69	22	2	6	0	0	1
Burr holes	1	8	13	15	19	15	28
Explor/suture peripheral nerve	0	7	9	15	21	21	27
Neuroplasty peripheral nerve	0	4	6	17	14	21	37
Remv foreign body,conjunctiva	29	34	9	12	8	3	5
Orbitotomy	0	1	10	12	18	22	38
Remv foreign body,eye struct	3	12	10	11	14	22	27
Removal of eyeball	0	1	3	11	14	28	43
Remove frn body,cornea/sclera	11	15	16	10	20	13	14
Excision of ext ear (all/part)	5	17	11	15	22	11	18
Reduction fx nasal bones	2	13	10	21	18	20	16
Repair open wound, neck	1	10	9	13	20	33	14
Suture/lig, intra-abd vessels	28	21	12	8	11	16	4
Venous anast,intrathoracic	1	10	7	9	12	39	21
Cardiotomy/pericardiotomy	0	8	1	9	14	47	21
Sutur/lig heart/periph vessels	0	4	1	7	11	44	33
Anastomosis periph vessels	1	10	9	11	18	34	16
Thoracocentesis	40	42	6	4	3	4	1
Chest tube insertion	27	55	8	3	2	4	1
Thoracotomy and pleurotomy	3	9	10	10	17	33	18
Lobectomy (part pheumonect)	0	2	1	4	13	41	39
Exploratory laparotomy	92	6	0	0	0	2	0
Debride abd wall,peritoneum	79	16	1	1	1	2	0
Hepatotomy	2	6	6	14	16	35	21
Liver resection	0	6	3	9	16	37	29
Pancreatectomy (partial)	0	3	3	6	13	40	34
Splenectomy	2	13	4	9	26	30	15
Resection (partial) of colon	2	17	7	13	20	31	10
Colostomy or ileostomy	6	24	6	14	25	19	6
Intestinal anastomosis	6	26	8	18	18	16	8
Repair op on rectum/anus	16	17	6	13	20	22	6
Repair kidney (wounds)	0	20	12	19	18	22	9
Nephrectomy, complete	1	6	7	7	30	30	19
Repair/anast of ureter	14	30	12	6	19	12	7

Orthopedic tasks are not the only tasks for which greater than 20 percent of general surgeons responded in categories 3 and 4, although such tasks may be the most important group. We observe similar findings for eye surgery, facial surgery, and neurosurgery. Training the general surgeons in all the tasks with a high response level in groups 3 and 4 would be impractical. One could consider choosing a subset of these tasks and clustering related tasks into coherent courses, which could be presented face to face, in audiovisual form, or on the printed page. Here in particular the need goes further than a course, because it is the frequent performance of procedures, and not merely familiarity with them, that is required to achieve and maintain proficiency.

Nearly all the eye procedures show a great deal of spread; that is, many general surgeons would never do the procedure, but others declare themselves ready to perform it. Approximately one-quarter of the general surgeons responding to our survey believe they could never do any eye surgery. The general surgeons as a group reject substitution for orbitotomy, removal of a foreign body from the eye structure, and scleroplasty or repair of the sclera. Not surprisingly, many of those who would perform some eye surgery report the need for some additional training.

In the entire task list presented to general surgeons, the only other tasks eliciting a substantial number of no answers are laminectomy with debridement and repair of the spinal cord, and open reduction and internal fixation of a fracture. In both of these cases, there was a marked amount of spread in responses—that is, although the response in general must be construed as a no, several general surgeons said they could perform the task.

The neurosurgical procedures other than laminectomy were accorded yesses by the general surgeons, with the proviso that all of them had more than 20 percent of responses falling into categories 3 and 4. Therefore, some additional training would be necessary in this area. It is nevertheless encouraging that general surgeons believe they could do burr holes. Among all the specialists we surveyed, they and the emergency medicine specialists were the only ones to say yes to burr holes. Other tasks in which general surgeons could substitute, although further training would again be required, include work on peripheral nerves, craniotomy and craniectomy (although approximately one-fifth of the general surgeons said never to craniotomy and craniectomy), and closed and open reductions of fractures of facial bones.

Surgical subspecialty examinations can be performed by general surgeons, but some additional training would be helpful. If such examinations will be required of general surgeons, it might be straightforward to provide the general surgeons with the information they will need to increase their preparedness.

SPECIALISTS IN OBSTETRICS AND GYNECOLOGY

Obstetrician/gynecologists have been identified as an important potential source of substitute surgeons. Approximately 30 percent of the Air Force's fully trained surgeons are ob-gyn specialists. They are almost as numerous as general surgeons. The Clinical Data Base offers ob-gyn specialists as substitutes for some general surgical tasks (delayed primary closure), some specific abdominal surgery tasks (liver resection), and some urology tasks, but no orthopedic tasks.

Among the tasks we asked the ob-gyn specialists about, few fall into the first two response categories (Table 4). They include intubation of airway, assessment of fluid and electrolyte requirements, insertion of a central venous pressure line, performance of lumbar puncture, administration of local or area anesthesia, major debridement requiring general anesthesia, delayed primary closure, suture or ligation of intra-abdominal vessels, thoracocentesis, chest tube insertion, exploratory laparotomy, debridement of the abdominal wall and/or

GENERAL SURGEONS

The substitution list, developed by the Army and included in the Clinical Data Base, lists the general surgeon as the preferred provider for the expected procedures (debridement of wound, delayed primary closure, general abdominal surgery) and some less obvious procedures; suture of peripheral nerve, suture and ligation of intra-abdominal vessels, and suture and ligation of heart and pericardium are procedures that might be done better by neurosurgeons or cardiovascular surgeons. General surgeons are also listed as the first, and frequently only, substitute for the other surgical specialists. The surgeons we interviewed before we fielded the survey indicated some hesitancy to substitute in neurosurgery and ophthalmology, both accepted as substitute roles in the Clinical Data Base.

The general surgeons responding to our questionnaire presented fewer surprises than the other specialty groups. As expected, general surgeons report that they have confidence in their ability to do "all" abdominal surgical procedures and thoracic surgical procedures. They are prepared to carry out specific surgery—such as hepatotomy, pancreatectomy, intestinal anastomosis, repair of urinary bladder, and suture of intra-abdominal vessels—as well as general surgical procedures such as major debridement, delayed primary closure, free skin grafts, thoracotomy, and exploratory laparotomy. In contrast, we will see below that the ob-gyn specialists we surveyed report themselves ready to perform general surgical procedures, but not specific ones.

Air Force general surgeons also believe they can carry out amputations and emergency procedures. However, given the projected need for physicians with operating room skills, it would not appear prudent to assign a general surgeon to the emergency room, except perhaps in the triage capacity. Expectedly, these general surgeons can carry out pre-operative and post-operative fluid and infection management; however, as will be shown below, there are several other more available and more numerous specialists who report preparedness for pre- and post-op fluid and infection management. Again, it may be wise to plan on using specialists other than the general surgeons for pre- and post-operative management, even though this represents a departure from civilian and peacetime military standard procedure.

Even for these general surgeons, there were certain procedures that they are able to do, yet more than 20 percent of them selected category 2 ("need practice"). Wherever category 2 is high, we infer that the general surgeons are not currently getting enough exposure to relevant patients or enough practice with the procedure. Examples of tasks perhaps requiring some kind of brushup are cardiotomy or pericardiotomy, anastomosis of peripheral vessels, lobectomy, liver resection, repair of the urinary bladder, and repair of an open wound of the penis. Although we have used the word "brushup," additional exposure to these tasks may in fact be difficult in Air Force hospitals.

The situation is different in the case of orthopedic surgery, where surgeons are currently identified as the preferred substitute for unavailable orthopedists. If these general surgeons are to perform most orthopedic procedures, they are going to need substantial help in the form of refresher teaching or full-scale training. The only orthopedic tasks the general surgeons are already prepared to do are amputations; with some brushup, they could perform simple closed reductions of fractures or dislocations. They would need training to perform open reductions of any type or closed reductions of fractures of the facial bones. For the open reductions and more complicated closed reductions, more than 20 percent of general surgeons are in categories 3 or 4—meaning that they think that a 1–4 hour or a 1–2 day course would be necessary. Furthermore, for most open reductions a substantial fraction of the surgeons, generally between 30 and 40 percent, answered in categories 5 and 6, suggesting the need for a major training effort to prepare them to perform these tasks.

Table 3—continued

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Resection (partial) of colon	100	0	0	0	0	0	0
Colostomy or ileostomy	100	0	0	0	0	0	0
Intestinal anastomosis	100	0	0	0	0	0	0
Repair op on rectum/anus	96	2	1	0	0	1	0
Repair kidney (wounds)	69	20	3	2	5	2	0
Nephrectomy, complete	75	15	3	1	5	2	0
Repair/anast of ureter	58	27	6	2	5	3	0
Repair urinary bladder	78	14	3	1	3	2	0
Repair open wound, penis	48	33	9	4	5	2	0
Debridement cmpd fx	62	25	7	2	2	2	0
Appl traction+ext fix	43	32	13	6	3	4	0
Clsd red:fx w,e,sh,k,f,clv	33	36	10	6	10	5	0
Clsd red:fx humerus,rad,ul	35	35	10	5	8	5	0
Opn red w int fix fx f,clv	11	22	14	12	18	18	5
Opn red w int fix fx ankle	7	21	16	8	18	23	7
Opn red:fx hand,fing,ft,to	17	17	16	10	15	19	5
Opn red/int fix:fx el,sh,k	5	17	14	11	16	27	10
Amput fingers and/or thumb	77	13	6	1	1	2	0
Amput through upper arm	71	17	5	5	1	2	0
Amput through lower leg	86	10	2	2	0	1	0
Closed red:disloc shoulder	65	27	4	2	2	1	0
Clsd red:disloc elb,w,k,an	29	47	11	3	7	2	2
Opn red:disloc fing/th,toe	26	28	14	11	11	7	4
Opn red:disloc knee,shldr	13	23	16	8	19	13	8
Reduction disloc jaw	35	32	15	6	4	5	3
Clsd red fx malar,zygom	10	26	16	19	14	8	7
Clsd red fx maxilla/mandbl	8	24	19	19	12	12	6
Opn red fx maxilla/mandbl	7	15	16	15	12	23	12
Fluid mgmnt pre&post-op	98	1	1	0	0	0	0
Infect mgmnt pre&post-op	99	1	0	0	0	0	0
Tendon repair	45	28	6	8	9	4	0

fracture—receive the "worst" rankings. Tasks in the middle line up in an entirely reasonable rank order. Even certain fine distinctions are maintained: For example, hepatotomy receives a slightly more prepared ranking than liver resection, and complete kidney removal is reported at a slightly higher level of preparedness than repair of kidney wounds, just as would be expected.

Nevertheless, our dependence on physicians' self-assessment of capabilities is a limitation of this study, although we do believe that by asking the physicians themselves, we obtained data more useful than we would have acquired by querying experts or by reviewing the literature on which tasks specialists are supposed to be able to do. At most, in our opinion, the specialists' responses might have been shifted to an unknown but small degree, in either the can-do or no-can-do direction, depending upon the self-assurance of the physicians making up the Air Force's stock of each type of specialist.

Table 3

RESPONSE FREQUENCIES: GENERAL SURGERY

(Percent of respondents)

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Infect mgmnt pre&post-op	112	1	0	0	0	0	0
Tendon repair	24	15	3	4	5	2	0
Intubation of airway	86	12	0	1	2	0	0
Cardiocentesis and pericardio	80	18	1	0	0	0	2
Assess fluid,electrolyte reqs	97	2	1	0	0	0	0
Insert central venous line	90	9	0	0	1	0	0
Interpret EKG	46	16	15	6	11	4	2
Interpret X-rays	91	3	4	0	1	2	0
Perform (specialist) ent exam	41	31	11	9	4	2	3
Perform (spec) neurology exam	40	27	16	12	3	2	1
Perform (spec) orthopedic exam	44	26	16	6	6	1	1
Perform (spec) oral (facmxl)ex	35	29	19	8	4	3	2
Perf (spec) neurosurgical exam	36	27	19	11	3	4	1
Perform lumbar puncture	81	17	1	1	1	0	0
Admin core rewarming procedure	29	32	25	5	4	2	4
Maj debridemnt-req gen anesth	100	0	0	0	0	0	0
Delayed primary closure	100	0	0	0	0	0	0
Free skin grfts-sites exc face	100	0	0	0	0	0	0
Free skin grafts to face	81	16	4	0	0	0	0
Craniotomy/craniectomy	7	25	11	12	11	15	19
Burr holes	25	33	12	13	8	4	4
Laminec w/debrd/repair sp cord	1	13	11	5	13	21	38
Explor/suture peripheral nerve	31	31	8	13	6	7	4
Neuroplasty peripheral nerve	17	34	13	12	4	13	7
Remv foreign body conjunctiva	70	19	4	4	2	1	1
Orbitotomy	1	9	11	15	14	17	34
Remv foreign body,eye struct	4	15	12	15	15	13	26
Removal of eyeball	9	14	14	13	15	13	23
Remove frn body,cornea/sclera	32	23	14	12	6	4	10
Suture of cornea	3	20	23	13	13	5	22
Scleroplasty/repair sclera	2	13	17	16	15	11	26
Excision of ext ear (all/part)	55	24	10	5	4	1	1
Reduction fx nasal bones	29	38	13	8	7	1	4
Repair open wound, neck	84	11	4	1	0	1	0
Suture/lig, intra-abc vessels	90	7	0	0	1	2	0
Venous anast,intrathoracic	45	22	8	4	7	7	6
Cardiotomy/pericardiotomy	41	21	5	5	9	10	8
Sutur/lig heart/periph vessels	42	26	4	6	11	4	6
Anastomosis periph vessels	66	21	2	4	6	1	1
Thoracotomy and pleurotomy	67	17	2	4	5	3	2
Lobectomy (part pneumonect)	34	33	6	7	7	10	3
Exploratory laparotomy	100	0	0	0	0	0	0
Debride ABD wall,peritoneum	100	0	0	0	0	0	0
Hepatotomy	80	12	2	1	1	4	1
Liver resection	58	25	3	5	4	5	1
Pancreatectomy (partial)	72	14	4	3	4	4	0
Splenectomy	99	1	0	0	0	0	0

who are working in their specialty from physicians performing other jobs, our request specified that the physicians be selected according to their duty specialty code (AFSC) instead of their primary AFSC. By specifying our sample this way, we missed some physicians we would have liked to survey; for example, our sample omitted many physicians serving part-time managerial functions such as Chief of Professional Services or Clinical Consultant to the Surgeon General. We did not exclude subspecialists until after the surveys were returned and processed.

We mailed surveys to 1120 physicians; of these, 32 were returned marked "undeliverable." Across all specialties, 79 percent of the delivered surveys were completed and returned. This response rate varied from a low of 73 percent for family/general practitioners to a high of 88 percent for emergency physicians. Table 2 gives the original sample size and returns by specialty.

Table 2

SAMPLE SIZE AND RETURNS, PHYSICIAN WARTIME CAPABILITY SURVEY

Specialty	Number Mailed	Number Completed	Number Undeliverable
Family/general practice	353	246	16
Pediatrics	200	160	2
Internal medicine	261	202	6
Emergency medicine	25	22	0
General surgery	146	123	5
Ob-gyn	133	106	3
Total	1120	859	32

How valid are these self-reports of the physicians' capabilities? Do doctors indeed know (and state) what they actually can and cannot do? An attempt at validation of the physicians' self-reports was beyond the scope of our study; and unfortunately, there is no published literature on the correlation between physicians' self-assessment and actual skills, externally evaluated. We therefore are limited to examining the data for evidence of face validity—determining that the responses are credible.

The pattern of response we see for all specialists who responded to our task survey provides the strongest type of prima facie support for the validity of the responses. Consider the responses from general surgeons (Table 3). Tasks that would be considered easy for general surgeons—e.g., intubation of airway, delayed primary closure, debridement, and pre- and postoperative fluid management—the surgeons say they can do. Difficult surgery, or surgery outside the everyday experience of the general surgeon—such as laminectomy with debridement and repair of the spinal cord, orbitotomy, and open reduction with internal fixation of a

II. FEASIBLE WARTIME SUBSTITUTIONS: THE PHYSICIAN WARTIME CAPABILITY SURVEY

This country has never had to mobilize quickly to treat wartime casualties, so experience does not tell us what substitute roles physicians trained in the different specialties could assume. Instead, we turned to the physicians themselves for self-assessment. We mailed a survey to all Air Force physicians assigned for duty in six specialties: family or general practice, internal medicine, pediatrics, emergency medicine, obstetrics/gynecology, and general surgery. All specialties might fill substitute roles in wartime, although emergency physicians and general surgeons would also be in demand as treaters of choice.

The survey instrument contained two parts. In the first part, the physicians answered questions about their training, medical experience in the Air Force and in civilian practice, and specific training or experience in treating trauma victims. These questions were identical for all specialties. The second part listed specific wartime treatment tasks and asked the physicians to indicate how much preparation they would need to perform each task. The responses were defined as follows, using a scale of seven responses:

1. I can do this comfortably now.
2. I can do this now, but it would take a few procedures to get me up to speed.
3. I could do this after a 1–4 hour refresher course.
4. I could do this after a 1–2 day refresher course.
5. I could do this after 3–10 days of training.
6. I could do this after 1–2 months of training.
7. I would never see myself doing this.

The task lists, differing by specialty, were drawn from clinical tasks defined in the Clinical Data Set. Although we were able to field the survey to only six specialty groups, we initially designed task lists for each major physician and nonphysician provider specialty, including podiatrists, physician assistants and nurse practitioners, oral surgeons, and dentists. A common list was developed for internists and pediatricians.

How did we decide which tasks would appear on each of the 17 lists? We began by identifying the discrepancies between two preliminary task substitution lists developed by the Army and Air Force for the Clinical Data Base. The lists included discrepancies in the preferred provider, the identification of potential substitutes, and the order of preference given these substitutes.[1] We also relied on opinions obtained from on-site interviews with physicians assigned to the Air Force hospitals at March AFB, Beale AFB, Mather AFB, and Travis AFB, and to Wilford Hall Medical Center. For each specialty group, we tried to offer a spectrum of tasks from different specialties that would be understaffed in wartime. We chose tasks expected to be judged as doable, questionable, and impossible. We favored tasks associated with the more frequent wartime patient conditions. Appendix C reproduces the general surgery survey and the complete set of task lists.

We requested the mailing list for the six specialties actually surveyed from the Air Force Manpower and Personnel Center. To avoid the potentially tedious job of separating physicians

[1]At that time, the Navy had not prepared a substitution list. Since then, the three services have agreed upon a common list.

tion IV. Section V presents these applications. We conclude in Section VI with a brief discussion of the methodology's other uses and the additional work needed to realize the model's full potential.

2. What limits does the peacetime population put on the number and specialty mix of physicians in peacetime and, therefore, on wartime capability? How important are retirees to sustaining this capability and what difference do authorizations constraints and physician supply ceilings make?

The results illustrate the potential of a well-designed substitution policy for increasing wartime capability and the importance of recognizing the inevitability of the constraints that peacetime medical operations put on wartime capability.

In wartime, substitutes may be able to perform work that might otherwise go undone. The price for this gain takes the form of increased training costs, a higher risk of poor outcomes, and potentially lower productivity. Information from the physician survey has allowed us to begin quantifying the first two "costs." The workforce design model can design productive substitution plans and provide measures of physician capability under different substitution policies.

The second model application analyzes the effect of several resource constraints on the ability of a peacetime active duty physician workforce to deliver needed wartime care. This analysis assumes that full advantage is taken of opportunities to substitute more plentiful specialties for scarcer (surgical) specialties. We consider two different types of limits on staffing:

- An inadequate supply of surgeons, combined with a ceiling on total physician authorizations;
- A decrease in the number of active duty physicians that can be kept busy due to the loss of retired patients.

The *total authorizations* for Air Force physicians in FY1985 will be about 80 percent of the PRISM III estimated peacetime requirement. Although the Air Force can probably reach the authorized level, supply shortages in surgical specialties will continue to hinder wartime capability. Our analysis is designed to estimate the effects on capability of these constraints.

Retirees and their dependents are treated on a space available basis within the military treatment facilities and have lowest priority for treatment. In the past, questions have been raised about the desirability of treating retired patients in military facilities. Today, it is presumed (though not proved) that military facilities provide care at lower cost than CHAMPUS. However, in the search for less expensive ways of providing health care benefits to all nonactive duty beneficiaries, the Defense Department is considering broadening CHAMPUS options to include Health Maintenance Organizations and other civilian providers. If these CHAMPUS changes draw patients from military facilities and force reductions in the size of the active duty physician workforce, wartime capability will decline. The connection between changes in peacetime benefits and wartime capability (or "readiness") is recognized but, to our knowledge, the connection has never been formally analyzed.

ORGANIZATION OF THE REPORT

The results of the Physician Wartime Capability Survey are presented in the next section and compared with the existing substitution policies represented by the Clinical Data Base list. Section III describes the workforce design model and the criteria used in solving the model. The data inputs developed for our illustrative applications of the model are described in Sec-

procedures most likely to be demanded in wartime were recorded for more than one patient per thousand.

To determine whether surgeons who serve in the Air Force lose war-related skills over time, we included the largest surgical specialty group—general surgeons—in the survey sample and asked them to assess their competency to perform trauma treatment tasks that would normally fall to a general surgeon.

PROBLEMS OF PLANNING FOR UNCERTAINTY

In developing wartime plans, the medical service is hampered by uncertainty. The number of casualties, the mix of conditions, and the timing and geographic dispersion of the workload are all unknown. The Clinical Data Base used by the Air Force to project its wartime physician requirements predicts these unknown factors from information on previous military conflicts, new technology, and professional judgment.

The presence of uncertainty does not absolve the medical service of its responsibility for wartime planning. In this context, formal analysis helps to identify areas of uncertainty and to illustrate the effect of various policies and external factors. Thus, the analytic results can guide planning that nevertheless must rely on the planners' judgment.

In trying to model the allocation of scarce physician resources to specific wartime tasks, we have encountered additional uncertainties. There is no information on the performance of substitute physicians in wartime, although we did obtain anecdotal evidence that such substitution has actually occurred from interviews with Air Force physicians who served in Vietnam and from Israeli physicians. Unfortunately, no wartime data sources exist from which we can estimate how much additional time substitutes take or the deterioration in the quality of care delivered by substitutes. We cannot hope to estimate these variables from peacetime data.

One strategy for planning around uncertainty is to exercise considerable judgment to select a single set of "reasonable" parameters. A better alternative is to develop plans for a range of possible parameters—i.e., conduct a sensitivity analysis—and develop the flexibility needed to respond to a range of scenarios. For the manpower allocation problem, the analysis must evaluate the effect of different *combinations* of parameters; this represents a more difficult task than merely analyzing changes in the parameters one at a time. Because this project did not include a sensitivity analysis, the results are as uncertain as the factors upon which they are based.

APPLICATIONS OF THE MODEL

The workforce design model has the flexibility to analyze a wide variety of manpower planning problems. These applications required different data inputs, some of them difficult to develop from existing data. We have applied the model, together with the survey results, to several problems that illustrate alternative uses of the model. Again, in some cases, we had to stipulate inputs that appeared reasonable. Our results depend on these inputs being, in fact, reasonable.

We applied the model to two sets of issues:

1. In wartime, what substitutions would most improve the capability of Air Force physicians? Would the improvement be significant, and how much training would the potential substitutes need?

studies showed that better surgical outcomes occur at hospitals performing a larger volume of the surgical procedures analyzed. Although none of the studies directly concidered the relationship between outcome and the number of times a physician performs a surgical procedure, the hospital-level results do support the suspicion that physicians' skills deteriorate without practice.

Early in this project, we analyzed the Air Force's automated inpatient records from the calendar year 1980 to see whether the peacetime workload allows active duty physicians to practice their wartime skills regularly. Here we present only a summary of this analysis as background for the the remainder of the report. A more detailed description of the analysis is in Appendix A.

We began by identifying diagnoses and procedures that are likely to occur in wartime, are less frequent in peacetime, and require specific physician skills. These inpatient records appeared to have more complete diagnostic than procedural information; so in view of the expected coexistence of certain diagnoses and the procedural skills that would be used to treat them, we chose to focus on diagnoses rather than procedures. Based on the three criteria, we categorized the diagnoses reported in 1980 as most wartime specific, less wartime specific, and wartime unrelated. To measure the volume of war-related work, we simply counted the number of times diagnoses from the first two lists appeared in the inpatient records. We also calculated the frequency of specific procedures required in wartime.

Table 1 summarizes the diagnostic results. Of the 273,760 records reviewed, only 3.6 percent reported any war-related diagnoses. Most of the diagnoses belong to the "less wartime specific" category, which includes a few common diagnoses: closed intracranial injury or fracture without hemorrhage, open head or ear wound, and myocardial infarction. Even at the largest medical center (Wilford Hall, with an operating capacity of 1000 beds), the physicians were exposed to only 164 "most specific" diagnoses and 1053 "less specific" diagnoses. That this implies limited opportunity for practicing war-related skills is demonstrated by the reported infrequent occurrence of the most common wartime procedures. Only two of the 15

Table 1

VOLUME OF WAR-RELATED DIAGNOSES, 1980

	Most Wartime Specific Diagnoses	Less Wartime Specific Diagnoses
Total war-related diagnoses, all hospitals	1298	11,012
Percent of inpatient cases	0.3	3.3
Average number per hospital		
Medical centers (275-1,000 beds)	67	510
Regional hospitals (35-200 beds)	21	208
Community hospitals (15-85 beds)	12	114
Total inpatient admissions	273,760	

The second component of the methodology, a mathematical programming model of "workforce design," provides the framework for systematically selecting a smaller number of *desirable* wartime substitutions. The relative desirability of each substitution is determined by the net gain (or loss) in patient outcomes. The model serves two other major functions: It describes the effect of peacetime operations and resource constraints on wartime capabilities, and it measures a physician's capability to handle the peacetime and wartime workloads. Capability is measured either by the volume of work that can be done or the degree to which desirable patient outcomes can be achieved.

This research is intended to complement efforts within the Air Force to develop a family of manpower planning models, called the Provider Requirements Integrated Specialty Models (PRISM), that estimate physician and some nonphysician requirements for both peacetime and wartime. The wartime model, PRISM II, uses a (wartime) Clinical Data Base developed as part of a tri-service research program in wartime medical planning. It includes lists of wartime diagnoses (called "patient conditions"), the treatment tasks performed for each diagnosis, and a preferred provider and one to four substitute providers for each task. The Clinical Data Base has much of the wartime data used in the workforce design model developed in this project. Throughout this report we use the terms "provider" and "physician" interchangeably.

PRISM also includes a peacetime requirements estimating model (PRISM III) and a less formal mechanism for adjusting the required staffing levels to conform to the number of positions authorized in the budget (PRISM I). PRISM III estimates the number of providers needed in each specialty to provide a full range of health care services to the patient population residing in the catchment areas served by Air Force facilities. In most specialty areas, the physician requirement estimated by PRISM III exceeds current staffing levels; the difference represents care the patient population receives from sources outside of the Air Force. In addition to modifying physician requirements to satisfy budgeted authorizations ceilings, the PRISM I process also incorporates constraints imposed by the supply of physicians to the Air Force and by facility and support staff limitations.

We use PRISM III outputs to calculate peacetime workloads for the workforce design model and information from the PRISM I process to structure the model's constraints.

HOW BIG IS THE PEACETIME-WARTIME GAP?

With the added sophistication PRISM brings to physician requirements estimation comes a heightened awareness of the big gap between peacetime and wartime requirements. But the gap between current physician staffing and wartime requirements is even bigger. The total numbers of active duty physicians in all specialties required in peacetime and wartime are nearly equal (at about 4500 physicians). However, the required mixes of specialists differ dramatically. Excluding physicians still in postgraduate training, the PRISM II and PRISM III totals are both about 4500 active duty physicians. However, the peacetime requirement for surgeons is only 1150 (26 percent); the wartime requirement is 2200 (49 percent). If we exclude obstetrician/gynecologists, the numbers are 900 in peacetime and 2125 in wartime. At the end of FY1983, the Air Force had 634 surgeons—450 without counting the obstetrician/gynecologists—out of a total of 2965 physicians not in training.

The PRISM estimates demonstrate that the different case mixes in peacetime and wartime lead to requirements for different specialty mixes. We further hypothesized that, particularly within the surgical specialties, the peacetime case mix would call for different skills than the trauma treatment skills of wartime medicine. As we describe in Appendix A, several

I. INTRODUCTION

In FY1983, the Air Force operated 81 hospitals and 37 ambulatory clinics in the Continental United States (CONUS) and overseas, staffed by just under 3800 physicians and physicians in training. The medical system serves two distinct missions. In peacetime, the medical system has responsibility for maintaining the health of the active duty workforce. In addition, it provides care to dependents of active duty personnel, retirees, and retired dependents on a space available basis. These beneficiaries also receive civilian care through the CHAMPUS program.[1] During wartime, the medical system provides medical support to the combat forces; CHAMPUS assumes responsibility for all other beneficiaries.

Air Force wartime planning recognizes the possibility that a conflict can break out without sufficient warning to mobilize reserve physicians. Should this happen, early casualties could be heavy at overseas air bases. In the early days or even weeks, the medical service would have to rely on its active duty workforce.[2]

Unfortunately, peacetime and wartime medical workloads require a considerably different mix of physician specialists. In peacetime, patients primarily use basic services in the specialties of family practice, internal medicine, pediatrics, and obstetrics/gynecology. Wartime casualties require a considerable amount of surgical treatment. Unless the Air Force wants to try keeping idle physicians on active duty, the peacetime active duty workforce will include an entirely different mix of specialists from that needed in wartime.

The problems generated by the differing peacetime and wartime workloads are exacerbated by the Air Force's continuing difficulty in recruiting and retaining surgeons. Since the draft ended in 1973, military pay levels for physicians have stayed below civilian earnings, particularly for surgeons. Sharp increases in the number of practicing physicians in the United States appear to be encouraging more physicians to choose military service (Hosek, 1983; Daubert, 1984). But the Air Force continues to have fewer surgeons than the peacetime workload could support. Moreover, a lack of peacetime trauma patients limits opportunities for practicing (and maintaining) wartime skills.

We have developed a methodology to assist the Air Force in finding solutions to physician manpower problems that arise from supporting two conflicting missions. The methodology has two components. The first, a survey of Air Force physicians, provides information regarding the wartime skills currently held by physicians in different specialties, and the training needed to enhance those skills. The survey results suggest several *candidate* wartime specialty substitutions. Without substitution, the only alternative to treating a wartime patient with the preferred provider may be to delay definitive treatment until after overseas evacuation. For this reason, we have included as candidate substitutions provider-task combinations shown by the survey results to require fairly long training programs and presumably extensive skill maintenance efforts. In this way, we do not rule out substitutions without first determining that the disadvantages of the substitution outweigh the advantages. Not surprisingly, the number of candidate substitutions is larger than the Air Force can effectively plan and train for.

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[1]Civilian Health and Medical Program for the Uniformed Services.

[2]The reserves are also understaffed in the surgical specialties, so mobilizing them would not necessarily solve the problem.

FIGURE

TABLES

Table 4—continued

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Repair urinary bladder	65	15	5	3	5	5	2
Repair open wound, penis	8	21	16	14	18	15	8
Debridement cmpd fx	6	23	8	16	16	22	9
Appl traction+ext fix	8	19	12	18	12	22	9
Amput fingers and/or thumb	4	18	15	19	15	19	10
Amput through upper arm	3	9	13	12	26	21	16
Amputation of foot	3	10	11	10	30	21	15
Amput through lower leg	3	9	11	11	30	21	15
Tendon repair	2	15	10	14	17	27	15
Fluid mgmnt pre&post-op	93	2	3	1	1	0	0
Infect mgmnt pre&post-op	94	4	1	0	1	0	0

peritoneum, repair or anastomosis of the ureter, repair of the urinary bladder, and pre-operative and post-operative fluid and infection management. These tasks, when viewed as a group, suggest that the ob-gyn specialists believe themselves to be prepared now to perform *general* surgical procedures; but the absence of many *specific* surgical procedures from the list implies to us that, at present, the Air Force's ob-gyn specialists would be of more limited initial utility in a conflict than the current substitution plans suppose. Alternatively, the ob-gyn specialists could even now be highly useful in an "assembly line" arrangement where they functioned in the operating room to debride, open and close, provide routine repair of vessels, and the like, while other surgically trained physicians separately carried out specific procedures.

For example, these ob-gyn specialists gave a definite no (at least 25 percent responding in category 7—"never will do") to lobectomy, liver resection, partial pancreatectomy, suture or ligation of the heart or peripheral vessels, reduction of fracture of nasal bones, excision of the external ear, removal of eyeball, removal of a foreign body from the eye structure, orbitotomy, neuroplasty of a peripheral nerve, exploration or suture of a peripheral nerve, burr holes, and performance of a neurosurgical examination. There is a second group of no answers, not quite so definite—here, the guideline was that generally no more than 20 percent of the specialists said never (category 7), and at least 40 percent of them answered with categories 5 or 6, meaning that their self-evaluation led them to conclude that they would require substantial amounts of further training before being able to perform these tasks. The tasks in this second category of "no, but just possible with substantial training" include hepatotomy, splenectomy, partial resection of the colon, colostomy or ileostomy, repair of the rectum or anus, repair of the kidney, complete nephrectomy, amputation of any type, tendon repair, thoracotomy and pleurotomy, anastomosis of peripheral vessels, cardiotomy or pericardiotomy, intrathoracic venous anastomosis, and repair of an open wound of the neck.

All in all, the definite and "softer" no answers of the above paragraph, when taken with the yesses reported above, describe a group of specialists aware of their limitations and conservative in their claims. One derives the impression that these ob-gyn specialists are confident of their general surgical skills, yet cautious about extending them. They believe they can perform general surgery; general abdominal and urological surgery is not seen as hopeless, but they are by no stretch of their own imaginations ready now to carry out such work; and amputations fare no better.

We ourselves must also raise a caution against attributing too many specific surgical skills to this specialty group, based on warnings that, although physicians can extend their range of tasks when the situation demands it, one must be careful about expecting substantial deviation from the normal range of activity, particularly during a conflict and even more so in the early stages of a conflict (Goldberg, 1982). Clearly, extended use of ob-gyn specialists in wartime would require *major* training, probably best conducted in major military or civilian hospitals and requiring each involved ob-gyn specialist to spend many weeks away from the normal duty post.

Most of the remaining responses from the ob-gyn specialists fell into the group where categories 3 and 4 together accounted for more than 20 percent of all responses, with most of the other 80 percent in categories 1 and 2. To us, such a pattern of response means that the specialty group is capable of performing these tasks if some special but fairly modest investment in additional training can be made. For example, a few days in another setting might increase the confidence and preparedness of these specialists and permit the Air Force to plan without uncertainty for them to perform these tasks. Falling into this category were the few orthopedic tasks we asked about, including debridement of a compound fracture, application of traction, and external fixation. Others in this group are intestinal anastomosis; removal of a foreign body from the cornea, sclera, or conjunctiva; and a few basic emergency tasks. However, only a few of these tasks require a modest training investment and therefore do not offer the opportunity for a large payoff, particularly when the training investment would probably need to be recurrent.

In sum, ob-gyn specialists can plainly play a role in the performance of surgical tasks. It is also evident that they are extremely uncomfortable about performing some surgical tasks we might have assumed they were prepared for or at least willing to do right now. If a major role is seen for ob-gyn specialists in specific surgical procedures, our findings indicate the need for considerable *specific* surgical training.

FAMILY PRACTITIONERS AND GENERAL PRACTITIONERS

Family practitioners and general practitioners (FPs and GPs) together represent the largest specialty in the Air Force, including 18 percent of all physicians in FY82. Family practice residency training includes obstetrics and some background in surgery. In Air Force practice, many FPs at the smaller hospitals assist the obstetricians with Caesarian sections and observe surgical procedures performed on their patients. The Air Force staffs its clinics with FPs in preference to GPs and classifies them as a single specialty. The Clinical Data Base lists very few primary tasks for FPs and GPs. The substitute list is longer and includes such tasks as physical assessment, emergency control of hemorrhage, intubation and tracheostomy, endoscopy, minor surgery, and discharge documentation.

The responses of FPs and GPs provide interesting information about the self-assessed ability of these physicians to perform a number of tasks required during a time of conflict (Table 5). The strongest and most unequivocal finding, perhaps not entirely expected, is (in general) the small amount of surgery these FPs and GPs feel comfortable doing.

"Minimal" surgery might be the best description of what FPs and GPs believe they are prepared to perform. A pattern consistent with a definite no is revealed for every single abdominal surgical procedure we asked about. Results are the same for urological surgery, neurosurgery, vascular procedures, thoracic surgery, eye surgery, and faciomaxillary surgery. Self-assessments of "cannot do" are also presented by the FPs and GPs for all the open reductions of fractures and amputations we listed in the survey. In general, orthopedics is an area where FPs and GPs state they cannot do the tasks now but would be able to learn.

Table 5

RESPONSE FREQUENCIES: FAMILY/GENERAL PRACTITIONERS

(Percent of respondents)

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Emerg surg control hemorrhage	46	27	8	6	6	7	1
Intubation of airway	64	31	4	0	0	0	0
Tracheostomy	15	39	27	8	8	2	0
Cardiocentesis and pericardio	21	38	20	9	8	2	1
Assess fluid,electrolyte reqs	81	9	6	3	1	0	0
Insert central venous line	55	35	8	2	1	0	0
Interpret EKG	90	4	3	2	1	0	0
Interpret X-rays	89	5	1	2	0	2	0
Perform (specialist) ent exam	36	24	18	11	4	5	1
Perform (spec) neurology exam	54	17	14	8	3	4	1
Perform (spec) orthopedic exam	49	19	11	11	5	6	0
Perform (spec) oral (facmxl)ex	16	25	30	12	9	4	4
Perf (spec) neurosurgical exam	19	19	29	13	7	6	6
Perform lumbar puncture	84	12	2	2	0	0	0
Admin core rewarming procedure	18	36	31	9	3	1	2
Admin local/area anesthesia	88	8	2	1	1	0	0
Maj debridemnt-req gen anesth	10	21	15	13	20	11	10
Delayed primary closure	22	24	18	11	11	10	4
Free skin grafts-sites exc face	6	16	12	13	22	18	14
Free skin grafts to face	2	5	11	12	18	21	31
Craniotomy/craniectomy	0	1	3	3	9	23	61
Burr holes	3	7	11	14	16	21	28
Explor/suture peripheral nerve	0	2	6	7	21	23	41
Neuroplasty peripheral nerve	0	2	3	6	13	21	55
Remv foreign body,conjunctiva	70	17	6	2	2	2	1
Remv foreign body,eye struct	18	13	11	10	10	12	26
Remove frn body,cornea/sclera	54	18	7	7	5	3	7
Suture of cornea	0	7	9	10	18	18	38
Scleroplasty/repair sclera	0	3	7	5	15	24	46
Excision of ext ear (all/part)	5	16	12	9	21	13	24
Reduction fx nasal bones	10	22	16	13	17	10	11
Repair open wound, neck	3	10	5	10	18	26	28
Suture/lig, intra-abd vessels	0	5	4	6	13	30	41
Anastomosis periph vessels	0	2	5	5	12	32	43
Thoracotomy and pleurotomy	2	4	3	5	8	24	55
Exploratory laparotomy	2	5	2	4	11	34	43
Debride abd wall,peritoneum	2	6	3	6	17	34	32
Suture abd wall (aft debride)	11	16	7	8	19	23	16
Splenectomy	0	2	3	4	9	34	48
Resection (partial) of colon	0	1	2	2	6	30	59
Colostomy or ileostomy	0	1	2	2	6	29	60
Intestinal anastomosis	0	2	1	3	5	29	59
Repair op on rectum/anus	0	1	1	2	4	34	58
Repair kidney (wounds)	0	1	3	1	7	30	58
Nephrectomy, complete	0	0	1	1	5	29	64
Repair/anast of ureter	0	0	1	1	4	31	62
Repair urinary bladder	1	2	1	2	5	36	52
Repair open wound, penis	1	3	4	5	16	30	41

Table 5—continued

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Debridement cmpd fx	3	11	5	8	21	26	24
Appl traction+ext fix	14	24	11	12	17	17	5
Clsd red:fx w,e,sh,k,f,clv	18	21	10	15	14	18	4
Clsd red:fx humerus,rad,ul	18	21	10	18	15	15	3
Opn red w int fix fx f,clv	0	2	4	4	12	31	46
Opn red w int fix fx ankle	0	2	3	3	6	33	53
Opn red:fx hand,fing,ft,to	0	3	3	4	9	33	49
Opn red/int fix:fx,el,sh,k	0	1	1	3	6	34	55
Amput fingers and/or thumb	3	11	9	11	22	19	24
Amput through upper arm	1	5	6	11	18	22	37
Amput through lower leg	1	5	5	11	19	23	36
Clsd red:disloc shoulder	41	27	9	7	6	6	4
Clsd red:disloc elb,w,k,an	12	30	17	15	13	7	6
Opn red:disloc fing/th,toe	4	6	7	7	17	20	40
Opn red:disloc knee,shldr	1	3	3	6	9	31	46
Tendon repair	5	10	10	9	17	25	23
Reduction disloc jaw	10	22	12	13	17	12	15
Clsd red fx malar,zygom	0	7	10	13	21	21	27
Clsd red fx maxilla/mandbl	0	6	7	14	22	22	29
Opn red fx maxilla/mandbl	0	0	1	5	11	27	55
fluid mgmnt pre&post-op	54	20	14	7	4	1	0
Infect mgmnt pre&post-op	60	17	12	5	3	1	0

Definite yesses were few, although that fact merely reflects our selection of tasks for the FP and GP survey. The definite yesses are assessment of fluid and electrolyte requirements, interpretation of electrocardiographic tracings and X-rays, performance of lumbar puncture, and administration of local or area anesthesia. Several other tasks were essentially yes, although at least 20 percent of respondents chose category 2, meaning it would take a few procedures to get completely up to speed: emergency surgical control of hemorrhage, intubation of airway, insertion of a central venous pressure line, and closed reduction of a dislocated shoulder.

For another group of tasks, at least 20 percent of the respondents answered with categories 3 and 4, implying the need for a refresher course of some length. Included in this group, where some attention to training might produce the most substantial payoff, are: major debridement requiring general anesthesia, delayed primary closure, free skin grafts to all sites except the face, performance of surgical subspecialty examinations, tracheostomy, cardiocentesis and pericardiocentesis, application of traction and external fixation, closed reductions of fractures, and pre- and post-operative fluid management. Tasks where a similar pattern emerged, but in this case responses 2 and 3 taken together were chosen by more than 20 percent of respondents, were: pre- and post-operative infection management; removal of a foreign body from the cornea, sclera, or conjunctiva; and removal of a foreign body from the eye structure.

As a generalization, then, FPs and GPs should be capable of first-assisting in surgery, being involved in pre- and post-operative management (after a bit of brushing up), and performing triage. They can also perform emergency tasks, although further training would be

helpful for subspecialty surgical emergency examinations. They can administer local and area anesthesia and perform minor surgery such as debridement, suturing, or incision and drainage. With some additional training, they might be able to perform major debridement requiring general anesthesia and delayed primary closure; thus, they could serve perhaps in a surgical "assembly line" arrangement where they could handle some fairly simple surgically related functions, but not the main event.

More than the other specialties, the FPs and GPs show a spread across the spectrum of answers from category 1 ("can do now") to category 7 ("never can do"). Examples of tasks with an especially notable spectrum of responses are: major debridement requiring general anesthesia, delayed primary closure, free skin grafts to all sites except the face, removal of a foreign body from eye structures, excision of the external ear, reduction of a fracture of nasal bones, suture of the abdominal wall after debridement, application of traction and external fixation, closed reductions of various fractures, and reduction of a dislocated jaw. When these FPs and GPs scatter themselves quite evenly across the range of possible responses, is training worthwhile or not? Perhaps the decision should depend on whether the training can be targeted on appropriate subgroups and on how valuable it is to have the FPs and GPs skilled in the task.

SPECIALISTS IN INTERNAL MEDICINE AND PEDIATRICS

The Clinical Data Base lists no primary or secondary tasks for pediatricians. Internists perform internal medicine exams as the primary treater and a few tasks, generally medical subspecialty exams, as the substitute treater. A central question in our research was whether these specialists (one-fifth of the Air Force's trained physicians) could perform a broader role in wartime.

We discuss the results for the internists and pediatricians combined because examination of the data for the two specialties taken separately revealed that these two specialty groups are equivalent overall; furthermore, relative showings for the various tasks faithfully parallel each other for these two specialties. Although from Tables 6 and 7 one might infer that internists generally seem to be more confident of their current preparedness, we show below that the differences are due to other factors. Pediatricians are clinically as acceptable as internists for all the tasks we surveyed, with the exception of gastrointestinal endoscopy (excluding proctoscopy), where the internists, although more secure, are also weak.

In surveying internists and pediatricians, we generally avoided querying them about surgically oriented tasks. The fact that induction of general anesthesia and debridement of the abdominal wall were definite no answers suggests that this decision was wise. It also would be very difficult, although not impossible, to turn these specialists into substitute anesthesiologists—one-quarter of the 352 respondents said they would never be prepared to induce general anesthesia, while a further 29 percent responded that it would take them one to two months of training to be able to perform this task; and 17 percent more signified a need for three to ten days of training.

The results do suggest that internists and pediatricians might fill some equally vital wartime roles. These specialists even now consider themselves prepared to perform the tasks necessary for basic resuscitation, and even to perform minor surgical procedures. In regard to the latter, more than 78 percent of respondents report themselves to be competent now to administer local or area anesthesia and more than 90 percent report themselves currently prepared to perform minor surgical procedures such as debridement, suture, and incision and drainage. This finding was not entirely expected, and it lends subsidiary support to our major

Table 6

RESPONSE FREQUENCIES: INTERNAL MEDICINE
(Percent of respondents)

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Emerg surg control hemorrhage	26	20	14	8	13	11	9
Intubation of airway	65	26	5	2	1	1	1
Tracheostomy	11	35	25	13	10	4	2
Cardiocentesis and pericardio	47	29	13	4	5	1	1
Assess fluid,electrolyte reqs	97	2	1	1	0	0	0
Insert central venous line	83	15	1	2	0	0	0
Interpret ekg	99	1	1	0	0	0	0
Interpret X-rays	90	5	3	2	0	0	0
Perform (specialist) ent exam	15	19	28	17	15	5	2
Perform (spec) neurology exam	65	17	10	5	1	2	1
Perf (spec) psychiatric exam	20	21	20	16	9	7	6
Perform (spec) orthopedic exam	10	15	23	20	20	8	4
Perf (spec) neurosurgical exam	13	17	24	16	12	11	7
Perf gi endoscopy (exc procto)	16	15	7	12	25	21	4
Perform lumbar puncture	95	5	0	0	0	0	0
Perf minor sur (debr,sut,i+d)	61	23	7	6	2	2	0
Admin core rewarming procedure	28	28	25	9	5	2	3
Induce general anesthesia	0	8	9	13	19	28	23
Admin local/area anesthesia	50	18	7	11	6	4	3
Remv foreign body conjunctiva	34	26	17	9	5	5	5
Remove frn body,cornea/sclera	21	24	16	15	13	3	8
Thoracocentesis	90	5	3	0	0	1	1
Chest tube insertion	31	45	16	5	2	2	0
Debride abd wall,peritoneum	3	10	9	7	18	25	28
Fluid mgmnt pre&post-op	83	8	6	2	1	1	0
Infect mgmnt pre&post-op	83	8	5	2	2	1	0
First-assist in surgery	25	28	7	7	13	15	5
Perform triage	58	20	9	5	6	2	1

finding for the internists and pediatricians—namely that these specialists will be able to "extend" surgeons by carrying out pre-operative and post-operative patient management.

Note that Air Force internists and pediatricians do think that they can perform fluid and electrolyte assessment (greater than 99 percent can do it now), and they feel comfortable in carrying out pre- and post-operative fluid and infection management. (Greater than 92 percent report themselves in categories 1–3 for both types of management.) The fact that both specialties believe themselves capable of performing triage (more than 85 percent in categories 1–3) further strengthens our conclusion that both internists and pediatricians can play an important role in providing care at the time of a conflict.

An item of possible utility might be a manual discussing and presenting guidelines on pre- and post-operative fluid and infection management. Such a manual should be written with a conflict in mind, rather than from the perspective of an academic medical center. The manual would stress management of fluid problems and infections in young people with traumatic injuries. One should keep in mind that these same reported fluid and infection management skills

Table 7

RESPONSE FREQUENCIES: PEDIATRICS
(Percent of respondents)

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Emerg surg control hemorrhage	22	29	14	10	8	9	7
Intubation of airway	66	25	4	3	2	1	0
Tracheostomy	6	31	27	13	18	3	3
Cardiocentesis and pericardio	18	25	22	10	13	7	5
Assess fluid,electrolyte reqs	87	9	3	1	0	1	0
Insert central venous line	23	43	16	11	4	1	2
Interpret ekg	53	12	16	10	4	4	1
Interpret X-rays	81	8	6	2	1	2	0
Perform (specialist) ent exam	34	18	19	13	8	6	1
Perform (spec) neurology exam	40	19	16	13	6	4	1
Perf (spec) psychiatric exam	15	11	21	18	15	15	4
Perform (spec) orthopedic exam	16	19	15	19	17	10	3
Perf (spec) neurosurgical exam	9	14	18	23	16	12	7
Perf gi endoscopy (exc procto)	1	3	8	10	26	32	20
Perform lumbar puncture	98	1	0	0	1	0	0
Perf minor sur (debr,sut,i+d)	67	18	8	4	2	2	0
Admin core rewarming procedure	10	32	38	10	5	4	2
Induce general anesthesia	0	3	7	18	15	30	28
Admin local/area anesthesia	47	27	8	10	4	1	1
Remv foreign body,conjunctiva	38	25	15	7	7	4	4
Remove frn body,cornea/sclera	17	26	20	10	13	8	7
Thoracocentesis	37	36	12	5	4	3	3
Chest tube insertion	39	36	12	7	4	2	1
Debride abd wall,peritoneum	3	4	9	14	16	22	32
Fluid mgmnt pre&post-op	55	20	12	6	3	3	1
Infect mgmnt pre&post-op	59	16	13	6	3	3	0
First-assist in surgery	30	28	6	5	10	15	6
Perform triage	51	18	16	6	6	3	1

imply that these medical specialists probably can also manage burn patients. The Israeli Defense Force has in fact been satisfied with the performance of internists in burn units.[2]

Both groups of specialists, internists and pediatricians, can therefore be assigned, as available, for pre-operative and post-operative management of patients. Furthermore, it is possible to envision their playing an important role in triage at any level of care. Triage is needed not only at the initial treatment site (Echelon B, a triage and resuscitation unit), it is also needed at higher levels of care (Echelon C, which delivers definitive care and stabilizes the patient, and perhaps even at Echelon D, where patients are held for overseas evacuation). Any time casualties arrive at a different level of care, fresh evaluation and triage are in order. The tasks of pre- and post-operative management and (if needed) triage will probably absorb many of the "excess" specialists of these two types. It may be worthwhile to reserve a few specific subspecialists from within the ranks of the internists and pediatricians—the renal, infectious

[2]This information comes from a series of interviews that we conducted with persons who have held important medical posts in the Israeli Defense Force. See Goldberg (1982).

disease, and hematology-oncology subspecialists—who may be particularly needed should there be casualties caused by nuclear, biological, or chemical agents.

There are several tasks where more than 20 percent of these respondents fall into categories 3 and 4 combined—that is, they are not ready to do the procedure right now, but not a great deal of time would be necessary to refresh their ability to perform the task. Among those tasks are emergency surgical control of hemorrhage, tracheostomy, cardiocentesis and pericardiocentesis, almost every type of specialist examination (particularly surgical subspecialty examinations), removal of foreign bodies from the conjunctiva or cornea or sclera, administration of core rewarming, and to a lesser extent, thoracocentesis. A short course (e.g., lasting two days) might fill the need efficiently, especially considering that most of the skills refurbished in this manner could be maintained in virtually all Air Force hospitals.

SPECIALISTS IN EMERGENCY MEDICINE

The Air Force has very few physicians trained in the new specialty of emergency medicine. This specialty will probably continue to be only a small fraction of the physician workforce. Although most Air Force hospitals operate an emergency room, most receive few emergency patients and fewer trauma patients. We surveyed the emergency physician specialists to determine how useful they would be in wartime and, therefore, how valuable their recruitment into the physician reserves would be. Probably because of their small numbers and recent recognition as a specialty, the Clinical Data Base recognizes emergency medicine physicians largely in a substitute role, primarily for emergency procedures.

The potential utility of an emergency medicine specialist in a receiving area at any echelon appears to be unquestionably high (Table 8). The responding emergency medicine specialists report that they can perform emergency tasks—including surgically related tasks, interpretation of electrocardiograms and X-rays, and specialty and subspecialty examinations. The only emergency procedures where there is even the slightest question of needing additional preparation are the tasks of performing a specialty psychiatric examination, a specialty faciomaxillary examination, administering core rewarming, and carrying out gastrointestinal endoscopy (which is not, strictly speaking, an emergency procedure).

Emergency medicine specialists and general surgeons are the only physicians among the different specialists completing this survey who feel they *could* do burr holes. Of the 22 emergency medicine respondents, 16 are currently able to proceed with burr holes.

"Internal" surgery appears to be outside their area of expertise, according to these specialists. They provide resounding no answers for ear, nose, and throat surgery; cardiovascular surgery; abdominal and urological surgery; and amputation. However, for some procedures, although the group as a whole denies it could perform the task, few of the respondents actually say never. Included in this category are induction of general anesthesia, anastomosis of vessels, debridement of the abdominal wall, and amputation. If the need were strong, more of these skills could be taught, but they would have to be maintained, as well.

It is somewhat disappointing that these specialists report themselves unable to perform many of the orthopedic procedures we listed in the survey. If a training course were deemed suitable, attention might be paid to some orthopedic tasks, particularly strengthening of skills to perform closed reductions of various types, simple amputations, and tendon repair. Suturing of the abdominal wall after debridement is another potentially fruitful area for training, if that is a task for which a shortage of personnel is predicted.

However, because the Air Force has only few emergency medicine specialists, careful assignment on the basis of current abilities probably makes more sense than designing any

Table 8

RESPONSE FREQUENCIES: EMERGENCY MEDICINE

(Percent of respondents)

Task	Now	With Practice	With Training				
			1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Emerg surg control hemorrhage	62	29	5	0	0	5	0
Intubation of airway	100	0	0	0	0	0	0
Tracheostomy	38	38	19	0	5	0	0
Cardiocentesis and pericardio	85	15	0	0	0	0	0
Assess fluid,electrolyte reqs	100	0	0	0	0	0	0
Insert central venous line	100	0	0	0	0	0	0
Interpret ekg	100	0	0	0	0	0	0
Interpret X-rays	100	0	0	0	0	0	0
Perform (specialist) ent exam	71	10	10	10	0	0	0
Perform (spec) neurology exam	81	10	5	5	0	0	0
Perf (spec) psychiatric exam	52	14	14	14	5	0	0
Perform (spec) orthopedic exam	81	10	0	5	5	0	0
Perform (spec) oral (facmxl)ex	67	19	5	5	0	5	0
Perf (spec) neurosurgical exam	76	10	5	5	5	0	0
Perf gi endoscopy (exc procto)	0	5	10	15	25	40	5
Perform lumbar puncture	100	0	0	0	0	0	0
Admin core rewarming procedure	71	14	10	5	0	0	0
Induce general anesthesia	5	0	10	29	38	19	0
Maj debridemnt-req gen anesth	5	14	10	5	29	29	10
Delayed primary closure	19	19	10	10	29	5	10
Burr holes	10	38	29	5	10	5	5
Explor/suture peripheral nerve	0	10	10	14	24	19	24
Neuroplasty peripheral nerve	0	5	5	10	33	19	29
Remv foreign body,conjunctiva	95	5	0	0	0	0	0
Remv foreign body,eye struct	24	24	5	5	10	0	33
Removal of eyeball	5	14	10	5	33	5	29
Remove frn body,cornea/sclera	90	5	0	5	0	0	0
Suture of cornea	5	15	15	15	40	5	5
Excision of ent ear (all/part)	0	24	10	5	29	10	24
Reduction fx nasal bones	10	33	19	24	5	0	10
Repair open wound,neck	5	5	0	24	19	29	19
Suture/lig,intra-abd vessels	0	5	0	19	14	48	14
Venous anast,intrathoracic	0	0	0	10	19	43	29
Cardiotomy/pericardiotomy	5	10	0	25	20	30	10
Anastomosis periph vessels	0	0	5	14	19	43	19
Thoracocentesis	76	19	0	0	0	5	0
Chest tube insertion	95	5	0	0	0	0	0
Exploratory laparotomy	0	0	0	5	18	55	23
Debride abd wall,peritoneum	0	9	0	9	32	41	9
Suture abd wall (aft debride)	9	14	14	27	9	23	5
Splenectomy	0	0	0	9	14	50	27
Repair kidney (wounds)	0	0	0	5	18	36	41
Nephrectomy, complete	0	0	0	5	9	36	50
Repair open wound, penis	0	0	14	5	23	32	27
Debridement cmpd fx	5	5	9	18	23	27	14
Appl traction+ext fix	38	19	5	14	14	10	0
Clsd red:fx w,e,sh,k,f,clv	14	32	9	5	23	14	5
Clsd red:fx ankl,tb,femur	5	27	9	14	32	9	5

Table 8—continued

Task	Now	With Practice	With Training: 1-4 Hrs	1-2 Days	3-10 Days	1-2 Mos.	Never
Clsd red:fx humerus,rad,ul	9	41	5	14	23	5	5
Amput fingers and/or thumb	9	14	18	23	18	9	9
Amput through upper arm	0	14	5	14	36	14	18
Amputation of foot	0	14	5	14	36	14	18
Amput through lower leg	0	14	14	5	32	18	18
Clsd red:disloc fng/thm/to	95	5	0	0	0	0	0
Clsd red:disloc shoulder	95	5	0	0	0	0	0
Clsd red:disloc elb,w,k,an	36	45	9	0	5	5	0
Tendon repair	14	41	23	14	5	5	0
Repr jaw fx w/inert subst	0	5	5	5	19	29	38
Reduction disloc jaw	67	24	0	0	5	5	0
Clsd red fx malar,zygom	0	10	15	20	20	15	20
Clsd red fx maxilla'mandbl	0	10	19	10	19	24	19
Fluid mgmnt pre&post-op	52	19	24	5	0	0	0
Infect mgmnt pre&post-op	33	29	33	5	0	0	0
First-assist in surgery	48	33	5	10	5	0	0

course particularly directed toward these specialists. Including them in an effort targeted toward a different, more numerous specialty group remains an option.

Finally, although the emergency medicine specialists do consider themselves capable of carrying out pre- and post-operative fluid and infection management, they are not as confident about their abilities in this area as are internists and pediatricians. Although it would still be rational to assign emergency medicine specialists to surgical pre- and post-operative management, they would be more usefully employed at the receiving level, with internists and pediatricians managing pre- and post-operative patients.

TRAINING, EXPERIENCE, AND WARTIME SKILLS

As we have described, the physicians within each specialty did report different skill levels for the same task. We analyzed the survey data to identify whether these differences were systematically related to the physicians' training and experience. The analysis, which used multiple regression techniques, is described in Appendix B.

By far the most important factor in explaining within-specialty differences in war-related skills is trauma experience. The relationship between the *level* of trauma experience and skill varied by specialty, but there appears to be no substitute for actual exposure to trauma patients. In contrast, we found only limited relationships between skills and such other variables as age at entry into the Air Force, length of service, osteopathic versus allopathic training, and foreign versus U.S. training. Foreign trained general surgeons did report greater skills in other surgical specialties, a finding consistent with the hypothesis that foreign general surgical training is less focused. Medical specialists who had attended any one of the short medical war training classes expressed more confidence in their war-related skills. Not surprisingly, these general training efforts have little effect on surgeons.

III. THE WORKFORCE DESIGN MODEL

Results from the Physician Wartime Capability Survey indicate the level of competence physicians in different specialties believe they have in a wide variety of wartime treatment tasks. Based on these results, one can identify potential substitutions of varying desirability and rule out some substitutions as being particularly infeasible. Recognizing that the Air Force has very few surgeons and that there may be no alternative to a substitute, ruling out a large number of potential substitutions a priori is undesirable. If one considers all but the most infeasible substitutions, however, there are too many possibilities for effective planning. To develop a meaningful substitution policy that can be supported by appropriate training requires that the adequacy of potential substitutes be weighed against the shortfalls to be filled.

The Air Force Surgeon General would like to design its wartime training programs around the specific tasks the physicians in each specialty might be asked to perform as substitutes. In the meantime, all active duty physicians are being assigned to wartime units that will staff specified contingency hospitals. For all planned contingency hospitals to be staffed, the assignments must involve substitution for scarce specialists. Both the training curricula and the unit assignments require a more precise definition of the expected wartime roles of each specialty than the survey results can supply. The wartime roles should be chosen to maximize the Air Force's ability to satisfy its wartime medical mission.

To assist in designing wartime roles for different specialties and explore the interrelationship between peacetime and wartime planning, we have constructed a model, called the *workforce design model*, that integrates multiple peacetime and wartime factors affecting the use of scarce physician resources and that can identify:

1. The optimal wartime assignments of physicians in the different specialties,
2. Policies that can be implemented in peacetime to reduce the gap between the physicians' peacetime and wartime capabilities.

The model uses information on peacetime and wartime workload requirements, the skills held by the different physician specialists, and the constraints on the total number of active duty physicians and the available supply in each specialty, together with a specification of the Air Force Medical Service's goals, to allocate both workloads to the same set of available physicians. When there are not enough physicians to satisfy both workload requirements, the model is forced to allocate some of the workload elsewhere (CHAMPUS in peacetime and perhaps nowhere in wartime); this decision is determined by the goals specified in the model. The solution describes the assignments made in detail and estimates the physicians' capability, when they are used most effectively, to perform the peacetime and wartime workloads. The wartime assignments use those substitutions that, despite the substitute physicians' lower skill level, contribute most toward attaining the Medical Service's goals.

The major purpose of our research has been to design the model and begin to develop its data inputs. We use a preliminary set of inputs to demonstrate the model's more important uses. This section focuses on the structure of the model; a description of data inputs follows in the next section. Our applications of the model (reported in Section V), emphasized specialty substitution, supported by targeted training programs, as a promising approach to developing a workforce with more skill flexibility and therefore improved wartime capability. The results point to substitute roles for peacetime specialties such as internal medicine, pediatrics, and

ob-gyn and show how resource constraints alter capability even with effective substitution. The model is well-suited to analyzing substitution policy, and we have paid particular attention to developing data on substitutions and designing measures of wartime capability that reflect the Air Force's established "mission," or goals, in wartime.

MODEL STRUCTURE

Figure 1 diagrams a simplified version of the workforce design model. To keep the analysis at a manageable level of detail, the model investigates the allocation of physician manpower for the system as a whole and abstracts from facility-level considerations. However, following the approach PRISM II uses to calculate aggregate physician requirements, the patient care workload is inflated by a "dispersion factor" in recognition of the expected variation in the geographic dispersion of casualties.[1]

The model begins with two sets of workload categories, one for peacetime and one for wartime (columns 1 and 3). The total amount of physician time needed for each of these workload categories is an input into the model. The list of treaters that may perform the work in each category is also prespecified (column 2). This list may include reserve physicians, although we have not included them in our applications. The straight lines (called "arcs") connecting the workload categories to the provider type categories indicate which providers can perform each type of work. The providers may be preferred or substitutes. Additional arcs connect all workload categories to the "CHAMPUS/Shortage" category to allow for the possibility that the work will not be assigned to any Air Force physician. In peacetime, CHAMPUS reimburses for care by civilian providers instead of in Air Force facilities and, in wartime, the "Shortage" label suggests that work not done by Air Force providers may not be done at all. The "unassigned" categories allow some physician time to remain unused if suitable work cannot be found; however, we have disallowed unassigned physician time in peacetime.

The model must assign all the required peacetime and wartime workloads to the provider types and to CHAMPUS/Shortage. In the diagram, it chooses which of the arcs will be followed for each component of the required workload. Each choice carries a penalty score per minute of assigned time. We define the penalty scores for wartime assignments as the mortality, morbidity, or inability to return to duty expected from each assignment. The peacetime penalty scores are defined by the costs and other disadvantages of not providing care in-house. The model selects the set of assignments that minimize the total penalty score, subject to a number of constraints (described below). In other words, the model minimizes adverse outcomes in both peacetime and wartime. Even when the workloads and staffing are aggregated across all facilities, the model must evaluate numerous alternatives. For example, the applications we developed to illustrate uses of the model, described in Section V, called for the model to consider over 15,000 arcs.

The model is formalized mathematically as a network model, a specialized form of linear programming. A more detailed description of the model is provided in Buchanan and Hosek (1983). We have programmed two versions of the model: the full peacetime and wartime version, just described, and a wartime-only version. The wartime version prespecifies the number of physicians available in each specialty and considers only how best to use these physicians in wartime. In Section V, we illustrate the application of this version to planning wartime roles for the existing physician workforce.

[1]Similarly, a "replacement factor" accounts for casualties among medical personnel.

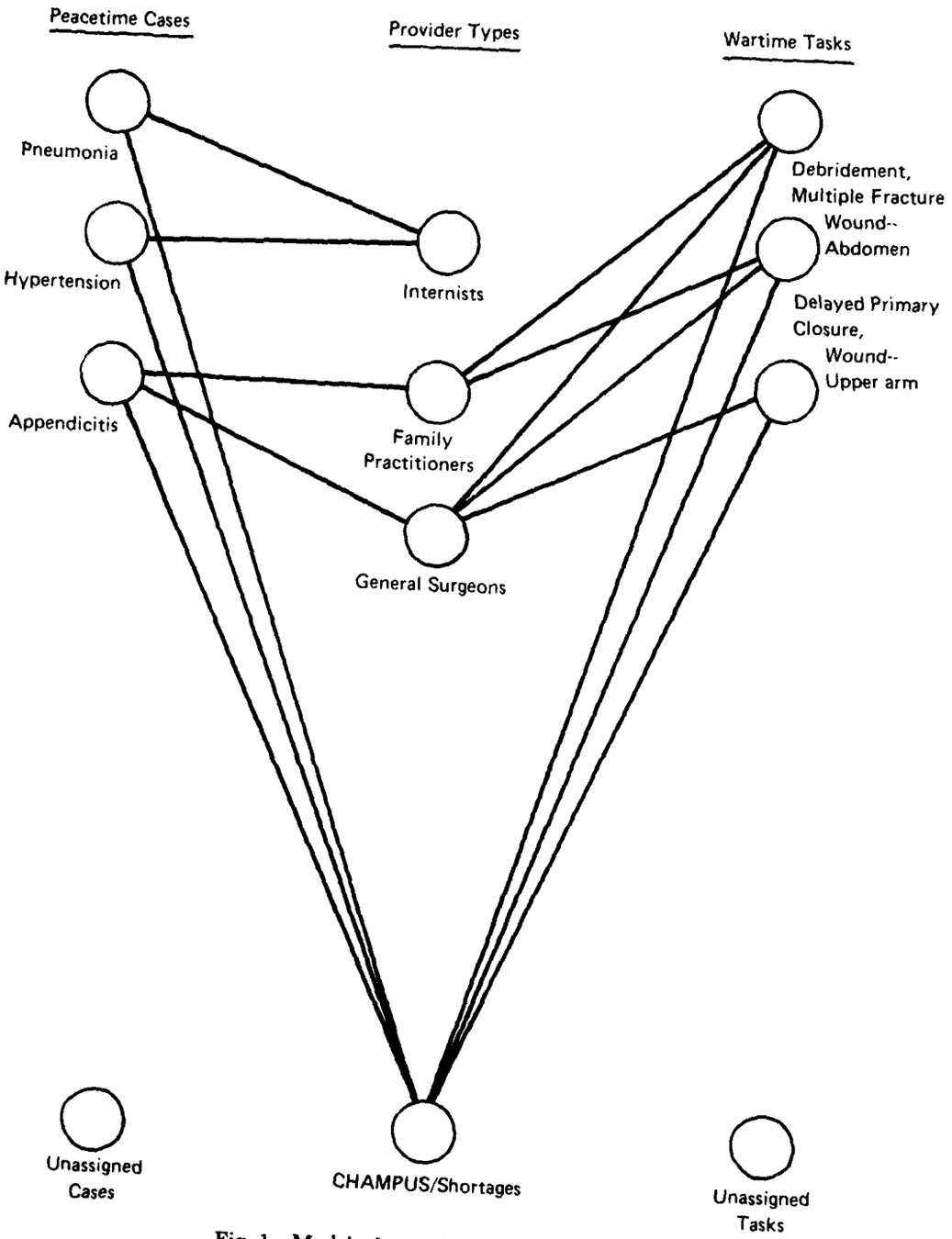


Fig. 1—Model of provider workforce design

Constraints

The model's choices must satisfy several important constraints. One constraint that we have already mentioned prohibits underemployment of physicians in peacetime. This constraint is easily removed, but keeping physicians on active duty without having an adequate patient load would be costly and undesirable from the physicians' viewpoint. Adopting this constraint automatically imposes a second constraint—the number of physicians in each specialty cannot exceed the number that can be supported by the peacetime workload; the workload is determined by the size and composition of the beneficiary population living near Air Force medical facilities, and, in the short term, by the facilities themselves. This requirement to keep the physicians busy in peacetime imposes a limit on the number of physicians available for wartime work.

The physician workforce is also constrained by the total number of active duty physician "slots" authorized by Congress and by supply ceilings in certain specialties, primarily in surgery.

Substitutions Allowed in the Model

Only commonly established substitutions are allowed on the peacetime side. These substitutions typically occur among primary care specialties. The boundaries between family practice and internal medicine, pediatrics, and obstetrics-gynecology are imprecise. In addition, physician assistants substitute for physicians in delivering primary care.[2]

The list of possible treaters for wartime tasks includes substitutions not commonly observed in peacetime. This expanded list is believed to reflect the more emergent conditions inherent in combat situations. An example of a substitution that might be considered only in wartime or some other disaster situation is given in Fig. 1. Connecting arcs show family practitioners as a potential substitute for general surgeons in the wound treatment tasks of debridement and delayed primary closure. Although family practitioners may not do this task well, the alternative of evacuating wound patients overseas before treatment may be far less desirable.

Penalty Scores

The penalty scores quantify criteria used in the model to determine workload assignments. In peacetime, the penalty scores should measure the differential costs of civilian care reimbursed by CHAMPUS versus in-house care. These costs are borne by the government and by the patients and include nominal cost differences as well as other differences such as in the patients' convenience. In wartime, as we discuss more fully below, the criteria are based on goals established in Air Force regulations: saving lives and limbs and returning personnel to duty.

For the model to simultaneously evaluate both peacetime and wartime assignments, the penalty scores must represent the relative importance attached to satisfying wartime versus peacetime demands. The approach we have taken first develops penalty scores for each of several outcomes: assignment to CHAMPUS in peacetime and death, morbidity, and failure to

[2]Nurse practitioners also provide care, especially in pediatrics and obstetrics and gynecology. However, because the Air Force plans to use nurse practitioners as nurses in wartime, we have included neither the nurse practitioners nor their peacetime workload in our analyses.

that we constructed to predict condition-specific mortality rates when treatment is deferred appears similar to Bellamy's predictions.[3]

We estimated mortality rates under conditions of delayed treatment at 0, 10, 25, 50, 75, and 90 percent, depending on the patient condition. Although many conditions set at higher percentages carry higher mortality rates even with treatment, the relationship between the treated and untreated mortality rates is not straightforward. In addition, the large number of conditions that are immediately treatable without risk of death would carry different mortality rates without this treatment. For example, the mortality rates for more moderate multiple abdominal wounds increase from 0 to 75 percent, and mortality from a closed wound of the spleen increases from 2 percent to only 25 percent.

Morbidity. After reviewing the penalty scores obtained from mortality and return to duty rates, we decided to add a crude indicator of the increase in mortality that could be expected if physician treatment were unavailable in the combat theater. Instead, we developed a simple scale of morbidity outcomes, calibrated to the mortality outcomes we obtained from the Clinical Data Base. Three levels of morbidity are incorporated for delayed treatment; these translate to mortality rates of 0.1, 1, and 3 percent. The lowest level reflects conditions that are uncomfortable but go away in time even without proper treatment. The middle level is associated with conditions having markedly more discomfort but no permanent effects. The highest level of morbidity is reserved for conditions likely to have permanent effects when treatment is unavailable.

Return to Duty Rates. We did not find any sources of combat return to duty rates other than the Clinical Data Base. We adopted a simple scale to represent the effects of delayed treatment on return to duty. Clearly, if prompt treatment will not return a patient to duty, neither will delayed treatment; a 0 percent return to duty rate remains at 0. We rated all other conditions—those with return to duty rates greater than zero after treatment—according to the proportion of patients we expected to return to duty without treatment. We used three possibilities: (1) all patients still return, (2) some patients still return, and (3) no patients still return. For conditions in the first category, the return to duty rates without treatment equal the rates with treatment. For the third category, the rates without treatment equal 0. For the second category, we assumed that 15 percent of the patients who could return with prompt treatment instead must be evacuated because of treatment delays.

Appendix D contains a complete listing of the penalty calculations for the abbreviated 250-patient condition version of the Clinical Data Set.

Translation from Condition Penalties to Task Penalties

In wartime, the medical system might adopt assembly-line treatment patterns, with different providers in different specialties performing succeeding tasks on a single patient. For example, an emergency medicine specialist might initially assess and triage the patient, several surgical specialists might operate on him, and an internist might assume most of the responsibility for his post-operative care. To capture this division of labor, we have studied the allocation of providers to the individual tasks required for each patient condition. Because the criteria upon which the wartime penalties are based refer to patient conditions, we had to develop a method for deriving task penalties from the penalties for the condition requiring the task.

[3]We did not make a direct comparison because we could not translate the Clinical Data Base multiple-diagnosis conditions into Bellamy's location classification scheme.

treatment systems and trauma care or in developing triage protocols (Krischer, 1976; Gibson, 1981; and Gustafson et al., 1983). These trauma scales measure patient severity by the expected outcome, either the probability of dying or the degree of morbidity. All the trauma scales that attempt to measure morbidity outcomes are defined on observations of the patient's physical status (e.g., degree of injury by body area, vital signs) instead of diagnosis. For this reason, we were not able to predict morbidity for the Clinical Data Base conditions from these trauma scales.

Penalty Scores. The penalty, P_j, for assigning the preferred provider to patient condition j is calculated as a weighted combination of the mortality rate, p_m, and the return to duty rate, p_r. We used equal weights, $w_m = w_r$, for the analyses in this report.

$$P_j = w_m p_m + w_r(1 - p_r)$$

Setting equal weights actually tends to give priority to patients that can be returned to duty because the model bases its selections on the penalty per minute of treatment time and "return to duty" conditions almost always require far less provider time and represent a modest share of the expected workload. The model will assign these conditions to the shortage category only if the supply of preferred providers, or reasonable substitutes, is severly limited. Therefore, increasing the weight on the removal from duty rates will have little effect. However, increasing the mortality and morbidity weights runs counter to Air Force policy, as quoted in Section III.

The Effects of Provider Nonavailability

If the allocation of physician resources leads to a patient's going untreated, at least for a period of time, and thereby worsens his outcome, the penalty rises. The increase in penalty for failing or delaying to treat a patient measures the deterioration in his expected outcome, compared with his expected outcome after prompt, full treatment.

Mortality. There are no real estimates of the effect on patient outcomes of deferring trauma treatment because, these days, treatment is rarely delayed, even under combat conditions. A review of the literature uncovered some general estimates of the effect of delaying treatment. Baxt and Moody (1983) found that, compared with ground transport, helicopter evacuation of civilian blunt trauma victims halved the mortality rate predicted from the Trauma Severity Index by lowering the average transport time from 58 minutes to 35 minutes and bringing more highly skilled treaters out to the patient. The authors suggest that prompter treatment contributed to the decreases in mortality from World War II (4.5 deaths per 100 casualties) to Korea (2.5 deaths per 100 casualties) to Vietnam (1 death per 100 casualties).

The only estimates of the effect of delayed treatment on mortality we found were published recently by Bellamy (1984). He predicts mortality rates over time for a hypothetical population of combat casualties, grouped by the anatomical location of the injury. These predictions are based on the decreases in the percentages of casualties killed in action from World War II to Korea. The mortality rate for this hypothetical population, with injuries distributed according to Vietnam data, is 19.5 percent after one hour, 26 percent after six hours, 32 percent after 24 hours, and 54 percent after one week. The one-week rate varies from 20 percent for injuries of the upper extremities to 100 percent for multiple-site injuries. The simple scale

Consequently, some of the parameters we used to calculate the scores could not be based on objective data, and we were forced to rely on our professional judgment and discussions with the Surgeon General's staff. These parameters include:

- The priority given to reducing mortality and morbidity versus returning personnel to duty in wartime,
- A scale for translating results from the Physician Wartime Capability Survey into measures of the deterioration in expected patient outcomes with substitution,
- Wartime patient outcomes when physician treatment is unavailable.

Further development of the workforce design methodology should include more work on the penalties and a sensitivity analysis, designed to show which parameters most alter the model's results. Because the effects of one parameter may depend on the values of other parameters, the sensitivity analysis must vary the uncertain parameters together, not just one at a time.

Wartime Penalty Scores

Section III defined the wartime penalties as a weighted sum of the rates of mortality, morbidity, and removal from duty expected to occur for each patient when treated by the preferred provider or a substitute provider, or when not treated by either. The weights reflect the relative priority given by the Air Force to avoiding each of the three outcomes. The workforce design model assigns treatment tasks, not patient conditions, and therefore it requires that the penalties be defined on tasks. To calculate a set of scores, we began by establishing estimates of mortality, morbidity, and return to duty rates and calculating penalty scores for the two extreme cases of treatment by preferred providers and no provider treatment. We next translated the patient condition penalties into treatment task scores specific to each condition, and we finally developed estimates of treatment task scores for substitute providers.

Penalty Scores for Patient Conditions Treated by Preferred Providers

A point of clarification is necessary here. It is important to distinguish between the penalties discussed here and triage priority. The model is a *static* allocation model; when presented with provider shortages, it decides which patient conditions will be treated and by whom, and which conditions will not be treated, at least by active duty providers. The model does *not* establish treatment priorities in the sense of determining the order in which the work should be done. The penalties do not convey information regarding urgency of treatment other than gross indications of how necessary is within-theater treatment.

Mortality and Return to Duty. The Clinical Data Base includes estimates of mortality and return to duty rates by patient condition, but no morbidity measures. In the 250-diagnosis version of the Clinical Data Base, only 57 patient conditions, when treated, might result in death after the patient arrives at a treatment facility in-theater and before he can be evacuated. The within-theater mortality rates range from one per thousand patients to 360 per thousand. Return to duty is at least possible for 152 conditions, expected for 10 to 100 percent of the patients. Only one condition can result in both death and return to duty, but 101 conditions neither cause death nor permit return to duty.

Morbidity. In hopes of finding information on morbidity, we surveyed several trauma severity scales that have been developed for use in retrospective evaluations of emergency

obstetrics-gynecology)—and *shortage specialties*—those staffed below the wartime requirement (surgery) as follows:

1. In each surplus specialty, the proportion assumed to be available for Europe equaled the ratio of the European active duty requirement for all specialties to the worldwide active duty requirement.
2. In each shortage specialty, the European share equaled the European-worldwide ratio for that specialty only. This ratio is lower than the overall ratio used for surplus specialties because surgeons and other shortage specialists are used sparingly in non-patient care activities.
3. The available manpower pool excluded physicians still in residency training.
4. The calculations ignored three active duty requirements: surgical assisting, CONUS "remote" facilities (located in "underserved areas"), and the CONUS dispersion requirement.

We dropped the three requirements in item 4 for three different reasons. Surgical assisting is not a task in the Clinical Data Base; the requirement is added, based on the number of required surgeons. Current Air Force policy calls for general surgeons to fill that requirement, but in recent years, dentists have been scrubbing for operations to learn surgical assisting and anesthesia skills. Adding this task to the data base and evaluating the potential for substituting dentists and others was beyond the scope of this project. The Air Force probably could find assistants among its medical residents and nonsurgeons or nonphysicians and we believed it more important to reserve the inadequate number of surgeons for surgery. We deleted the requirement for remote CONUS facilities because there are few remaining medically underserved rural areas (Williams et al., 1983). Finally, we did not multiply the CONUS requirement by a disperson factor because this requirement is not based on workloads that would vary less over time and across locations compared with overseas workloads.

CALCULATION OF PENALTY SCORES

In the previous section, we described the general structure and function of the penalties within the workforce design model. Because we could not demonstrate the model without a workable set of penalties, we developed an initial set of scores to represent wartime priorities.

We did not attempt the development of a comparable set of peacetime penalties, primarily because this would require extensive analysis for which existing data are inadequate. For this and other reasons, we believed that our efforts would be better spent on penalties for wartime instead of peacetime. Peacetime penalties affect workforce choices only to the extent that the constraints imposed allow flexibility in manpower planning. The requirement that active duty physicians be fully employed in peacetime, added to the constraints imposed by current authorizations and supply ceilings, severely limit this flexibility. Penalty scores for peacetime substitutions are unnecessary because we have included only those substitutions that are commonly accepted and currently observed both within and outside of military medicine.

In place of a more complicated scheme, we stipulated that each minute of peacetime workload assigned to the CHAMPUS program would incur a unit penalty. This small penalty guaranteed that the model would prefer to assign peacetime work to the active duty physicians instead of CHAMPUS.

The wartime penalties are based on measures of expected outcomes when substitute physicians treat patients or when treaters are unavailable; these measures are not readily available.

the peacetime workload to a wartime-equivalent workload—the workload that physicians could handle in peacetime if they worked on wartime schedules. This is accomplished by multiplying the peacetime workload estimates derived from PRISM III by the ratio of the number of minutes worked in wartime to the number worked in peacetime.

PROVIDER SPECIALTY GROUPS AND THE SUPPLY CONSTRAINTS

The workforce design model uses the same specialty and subspecialty categories as the Clinical Data Base. The categories are defined by the Air Force's occupational specialty codes and are therefore consistent with PRISM III specialty categories. We omitted aerospace medical specialists, preventive and occupational medical specialists, pathologists, pharmacologists, and pathologists because their work is not represented in the Clinical Data Base or they do not give direct patient care. We included nonphysician providers who: (1) are currently included in the active duty force in reasonable numbers; (2) are trained to perform physician tasks; and (3) in wartime, would not be in short supply for crucial nonphysician tasks.

The overall ceiling on the number of physicians in all specialties is determined by the physician authorization for the time period being analyzed. The supply ceiling in each specialty depends upon the problem to which the model is being applied; in our applications, the supply ceilings equal the physician endstrength (number on board on a given date) or an estimate of the number of physicians that the Air Force can recruit and support with facilities and staff.

RESCALING INPUTS TO ANALYZE EUROPEAN THEATER CAPABILITY

In developing the Clinical Data Base, priority was given to NATO requirements and to the Central European Theater in particular. Although data for other requirements are now becoming available, the data base we used contains only NATO information. For this reason, the wartime workload data we use in the model describe patient-care activities expected to be required in the European theater. In wartime, active duty physicians would also be needed for other duties, including patient care in other areas and nonpatient care tasks. Because we were analyzing a partial requirement, we had to adjust the manpower supply constraints, total and by specialty, downward.

The model uses several manpower data inputs that required adjustment. The overall ceiling on the number of physicians in all specialties is typically determined by the physician authorization for the time period being analyzed. Depending on the version of the model and the problem, the ceiling in each specialty represents the physician endstrength or estimated supply ceilings. Finally, if we disallow peacetime underutilization of physicians in the full model and thereby restrict the number of usable physicians, we must also adjust the peacetime workload in recognition that some of that workload is effectively supporting non-European wartime requirements.

The adjustments were based on data supplied by the Air Force and adopted the general criterion that each type of physician requirement (patient care, nonpatient care by location) should receive a "fair share" of available manpower. To calculate the numbers of physicians we would allocate to the European theater, we followed the rules listed below. The rules differed for *surplus specialties*—those staffed above the wartime requirement (medicine, pediatrics,

pre-evacuation maintenance care. For each patient condition at each level, the data base lists the expected length of stay, the bed type (intensive, intermediate, or minimal care), the tasks that need to be performed, and disposition. Dispositions are reported as proportions expected to die, return to duty, and be evacuated; for evacuees, the next level of care is specified. A separate data file indicates the amount of time required for each task (independent of the patient condition) and the preferred and substitute providers for the task. Substitutes are assumed to take no more time than preferred providers take to perform a task.[2]

The data base does not contain the information needed to estimate the total patient load because these estimates are not prepared by the Surgeon General. It does contain the expected frequency of occurrence of the 309 patient conditions within the patient population. As we indicated above, this frequency is specific to the Air Force.

The workforce design model uses data from the Clinical Data Base in modified form. To gain computational efficiency, we condensed the patient condition list to 250 conditions by combining infrequent conditions with other conditions having a similar treatment regime. We also deleted tasks handled by personnel other than physicians or nonphysician providers (nurses, technicians, corpsmen, and other support personnel). The data base's task list is more comprehensive than the list dictated by the patient condition list. We removed the tasks not called for by the patient conditions' treatment regimes. Several groups of tasks that nearly always occurred together and would logically be performed by the same provider were combined into a single task.

For most patient conditions, the Clinical Data Base included only one 10-minute task for monitoring patients during or after treatment. We created four new tasks for pre- and post-operative care of surgical patients and monitoring of medical patients. Patients in intensive care are examined four times a day, twice by a specialist and twice by nonspecialists. Patients in intermediate beds are observed twice each day, once by a specialist. Minimal care patients receive one visit, by specialists and nonspecialists on alternate days.

PEACETIME WORKLOAD DATA

PRISM III estimates the number of physicians needed to perform the workload generated at each facility by each type of beneficiary and by clinic service, which is roughly equivalent to specialty. PRISM III inputs include: (1) the beneficiary population living within 40 miles of each Air Force hospital and clinic; (2) outpatient utilization rates, measured in monthly visits, for each clinic service; (3) physician workload factors, measured as the number of outpatient visits per month that a full-time physician can handle, depending on the number of beds in the facility; (4) substitution rates of nonphysician providers for physicians; and (5) various minimum staffing rules. The PRISM III output lists the number of physicians required to satisfy patient demands, with and without the imposition of the staffing rules. Subspecialties are modeled outside the PRISM III framework.

In wartime, a physician would work 12-hour days, with very little time devoted to activities other than patient care. The workforce design model accommodates differing peacetime and wartime work schedules (i.e., differing time inputs from the same workforce) by inflating

[2]At least initially, substitutes would probably take more time. Modeling constraints forced us to assume equal performance times. Support for this assumption came from two sources. The physicians we interviewed who had combat experience told us that all physicians, including substitutes, soon pick up their pace of work, but that their technique does not improve so easily. Second, the Clinical Data Base also assumes equal treatment times for preferred providers and substitutes.

IV. DATA INPUTS USED IN MODEL APPLICATIONS

The workforce design model requires detailed data inputs describing:

- The number of physician minutes in the peacetime workload by specialty or, if possible, by case type;
- The number of physician minutes in the wartime workload by task;
- The maximum number of physician minutes available by specialty;
- The total number of physician minutes allowed by the ceiling on physician authorizations;
- A list of the peacetime cases and wartime tasks that each specialty is capable of performing;
- The penalty per minute associated with each task-specialty or case-specialty combination.

The Clinical Data Base provides much of the wartime information, although not necessarily in the format used in the model. As provided to us, the Clinical Data Base's several data sets provide detailed treatment information on 309 patient conditions expected to occur in wartime; the Air Force has developed its own expected frequency of occurrence for the 309 conditions, based on expected causes of injury and disease on its air bases. Combining the Clinical Data Base files and the frequency of occurrence specific to the Air Force, we can derive the required wartime workload. The Clinical Data Base also includes the tri-service substitution list and mortality and return to duty rates that are suitable estimates of the penalties for patients treated by the preferred provider. Preliminary information for the remaining penalties (for treatment by substitutes or by no one at all) was developed as part of this project.

PRISM III, the Air Force's peacetime provider requirements model, supplies the data from which we calculate the peacetime workload requirement. Data for estimating peacetime penalties are not readily available. Finally, we obtained information to establish authorizations and supply ceilings from published Air Force manpower data and from data supplied by the Surgeon General's Office.

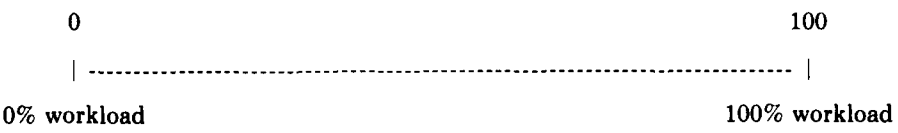
In this section, we summarize our adaptation of the Clinical Data Base and PRISM III outputs for use in the model. Additional details may be found in a companion volume (Buchanan, 1984). We also present a more thorough description of our efforts to develop penalties for use in applying the model.

WARTIME WORKLOAD DATA

The Clinical Data Base is frequently updated. The version of the Clinical Data Base supplied to us is built around 309 patient conditions,[1] 751 treatment tasks, 137 treaters (including physicians, nonphysician providers, nurses, corpsmen, technicians), and seven levels of care. Four levels of care are situated within the theater and provide first aid; resuscitation, emergency care, and triage; the within theater definitive and comprehensive treatment; and

[1]Examples include: (1) fracture, facial bones, closed (exclusive of mandible), severe—multiple fractures; (2) burn, thermal, partial thickness, upper extremity, severe—greater than 10 percent total body area involved; (3) wound, abdominal cavity, open, with lacerated, penetrating perforating wound of the kidney, moderate—lacerated kidney; and (4) shigellosis (bacillary dysentery), moderate—all cases. Many patient conditions involve multiple diagnoses.

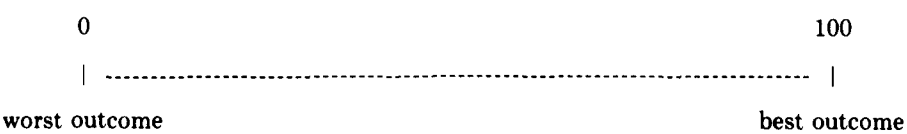
open fracture substitution and instead allowing the general surgeons to substitute in amputations, for which it assigns a smaller penalty score. Also suppose that we have extra general surgeons, but too few orthopedists and that the open fracture workload requires more physician time than the amputation workload does. If the model solutions for these two substitution lists differed only in the assignments given to the general surgeons, the first substitution list could yield the higher workload capability while the second list yields the larger outcome capability. The conflicting results would occur only if the difference in penalty per minute of task time were larger than the difference in the task minutes required by the fracture and amputation workloads. In practice, none of our applications of the model resulted in conflicts between the workload and outcome measures of capability; if changes in the substitution list or resource constraints increased workload capability, they also increased outcome capability.



The workload measure, although simple to grasp and useful as an indicator of the size of remaining shortfalls, measures how much work can be done, but not what can be done. A minute of time spent evaluating a patient with a cold carries the same weight as a minute of time cleaning out a wound. Therefore, we also use a second measure, called the *outcome capability measure*, which uses the penalty scores to value the tasks assigned to the physicians and to shortage. The penalty scores measure the deterioration in expected patient outcomes (mortality, morbidity, return to duty) if treatment cannot be provided in the theater or if substitute physicians are used.

The best outcomes can be expected with full and prompt treatment by preferred providers. Even in these circumstances, some patients will die and many patients will not return to duty, so the best outcomes still result in penalty scores. However, the total penalty score will be minimized. The worst outcomes result from no treatment, and the penalty score is maximized. Somewhere between these two extremes lie the outcomes, and the penalty score, when substitute physicians treat the patients. The workforce design model is constructed to maximize patient outcomes within the manpower and other constraints we specify. The model maximizes outcomes by selecting the task assignments to each specialty and to the shortage category that minimize the total penalty score. Therefore, the penalty score associated with the model's solution represents the best outcomes achievable with the available manpower and under the specified substitution matrix and constraints. If we compare this penalty score with the minimum penalty score (best outcomes) that results from ideal treatment and the maximum penalty score (worst outcomes) that results from no treatment, we can see how close the physicians can come to full capability, measured by patient outcomes.

To facilitate comparisons between the workload and outcome measures, we have defined the outcome measure on the same scale of 0 to 100 that is used for the workload measure.



For the outcome measure, the 0 point on the scale represents achievement of the "worst" possible outcome for all patients and 100 represents achievement of the "best" possible outcome for all patients. In other words, the minimum penalty score has been reindexed to 0 and the maximum penalty score has been reindexed to 100. The outcome measure thus equals the percent of the difference between the minimum and maximum penalty score that the physicians can achieve.

In Section V, we use the two capability measures to evaluate different substitution lists and resource constraints. In theory, when comparing alternatives, the two measures need not result in the same rankings. For example, suppose we wanted to compare two substitution lists. The first list allows general surgeons to substitute for orthopedists in open fractures but assigns a high penalty score to this substitution. The second list differs only by dropping the

Table 11

THE USE OF PENALTIES: CASE 3

	More Serious Condition A (2 units of treatment time per patient)	Less Serious Condition B (1 unit of treatment time per patient)
With Physician:		
Expected mortality	.10	.10
Penalty per unit time	5	10
No Physician (shortage):		
Expected mortality	.20	.16
Penalty per unit time	10	16
Total penalty when physician chooses to treat condition	5 + 16 = 21	10 + 10 = 20
Preferred condition for physician to treat?	no	yes

MEASURES OF CAPABILITY

It is desirable to have a scalar metric that can be used to compare the potential capability of different workforce structures in wartime. The most common measure of capability now used compares a physicians requirement (e.g., for wartime) with the number of active duty physicians on hand. The comparison may be drawn separately for each physician specialty, although comparisons that ignore specialty mix are made frequently. This input-based capability measure is useful for setting recruitment goals, but it is less informative about how close the physicians on hand (the inputs) can come to satisfying the required workload (or output). We have developed two output-based measures of wartime capability that describe the maximum output achievable at different physician staffing levels.

The first capability measure is defined as the percentage of the total workload, measured in minutes of physician time, that the physicians can accomplish. Solving the workforce design model provides information, for each task, on the proportion of the time required to perform that task on all patients that can be allocated to the physicians and the proportion that must be allocated to the shortage category. By summing o er all tasks, we can easily calculate what percent of the total time requirement can be allocated to physicians and what percent falls into the shortage category. The percentage allocated to physicians gives us a straightforward measure of capability. This *workload capability measure* falls on a scale between 0 and 100:

Table 10

THE USE OF PENALTIES: CASE 2

	More Serious Condition A (1 unit of treatment time per patient)	Less Serious Condition B (1 unit of treatment time per patient)
With Physician:		
Expected mortality	.10	.10
Penalty per unit time	10	10
No Physician (shortage):		
Expected mortality	.20	.16
Penalty per unit time	20	16
Total penalty when physician chooses to treat condition	10 + 16 = 26	10 + 20 = 30
Preferred condition for physician to treat?	yes	no

When conditions require different amounts of physician time, the *penalty per unit of physician time* determines the outcome.

The physician can now treat the two patients with condition B or one patient with condition A; the former is preferred in this example. If the expected mortality without treatment for condition B had been .14 instead of .16, the physician instead should treat the one patient with condition A and allow the two patients with condition B to go untreated.

Looking at all the examples cited above, the results are not always easy to predict because they may be counterintuitive. The relative seriousness of the conditions is responsible for the size of the penalty scores incurred in the "physician" column; the difference that treatment makes determines the penalty score placed in the "no physician" situation column. When treatment times are unequal, the physician is asked to treat patients where a minute of his time is most productive in improving outcomes.

These three cases ignore additional factors that enter into the calculation of how best to assign a limited stock of physicians. The first factor is the availability and quality of substitutes. Physicians will be assigned to substitute roles before they are assigned to primary roles if the conditions for which they substitute are more responsive to treatment (adjusting for treatment time) and the physicians are good enough substitutes. Second, the outcomes that determine the desired time allocation include morbidity and return to duty in addition to mortality. These other outcomes affect the allocation of physician time in the same way as mortality does in the examples, but the need to consider multiple outcomes makes the decisions somewhat less transparent.

Table 9

THE USE OF PENALTY SCORES: CASE 1

	More Serious Condition A (1 unit of treatment time per patient)	Less Serious Condition B (1 unit of treatment time per patient)
With Physician:		
Expected mortality	.10	.02
Penalty per unit time	10	2
No Physician (shortage):		
Expected mortality	.13	.07
Penalty per unit time	13	7
Total penalty when physician chooses to treat condition	10 + 7 = 17	2 + 13 = 15
Preferred condition for physician to treat?	no	yes

A (.13 – .10). This is counter to the natural inclination to treat more serious conditions first. Condition A is so serious that timely physician treatment reduces mortality by only three percentage points and thus reduces the penalty score only from 13 units to 10 units. In contrast, for condition B, timely physician treatment can reduce expected mortality by five percentage points and the penalty by five units.

Another way of viewing Case 1 is to observe that if we assign the physician to condition A, condition B goes untreated. We incur a penalty of 10 units for the condition A assignment and another 7 units for failing to treat condition B, for a total penalty score of 17 units. This compares unfavorably with the penalty score (15 units) if we were to assign the provider to condition B (2 penalty units) and allow condition A to go untreated (13 penalty units).

Let us now consider an example (Case 2) where the mortality rate is the same for either condition when a physician is available, but one condition has more serious consequences of delayed or unobtained treatment. In this event, the physician treats the condition with the more serious consequences of delayed treatment. Table 10 illustrates the calculations. In the opposite situation, the mortality rates would differ when a physician treats the condition but remain the same for delayed or unobtained treatment of both conditions, and the physician would treat the condition with the lower mortality rate after treatment.

Case 3 (Table 11) increases the complexity of the problem presented by Case 2. Condition A of Case 2 now requires two units of physician time while condition B still requires only one unit of physician time. In this situation, the physician can treat two patients with condition B in the same amount of time that it would take to treat one patient with condition A.

According to this principle, a provider will not devote a large amount of time to a patient with a low survival chance if his chances of saving other lives or limbs are considerably better.

2. Providers should be allocated where they have the greatest *relative* advantage, not necessarily the greatest *absolute* advantage. Thus, an internist may substitute for an unavailable surgeon in high priority post-operative care although the internist would do a better job at treating other lower priority medical conditions.

HOW WARTIME MEDICAL PRIORITIES ARE REPRESENTED WITHIN THE MODEL

Even with the best of care, wartime casualties die, suffer permanent impairment, or must be evacuated and replaced with (less experienced) personnel. A delay in treatment or use of less skilled providers will generally result in a greater number of these adverse outcomes. The workforce design model includes estimates of the probabilities of adverse outcomes and a measure of the relative priority placed by the Air Force on avoiding the different outcomes. The model can be described as a "damage minimization" model. It assigns physicians to treatment tasks in such a way as to incur the lowest level of bad outcomes. This approach is conceptually equivalent to the opposite approach of maximizing good outcomes.

The adverse outcomes of mortality, morbidity, and failure to return to duty are represented by *penalty scores*. The penalty score for a death or for not returning to duty is a simple transformation of the probability of the events. We were unable to find information suitable for developing morbidity penalty scores, so we used low mortality penalty scores to proxy morbidity. In this scheme, a given level of morbidity is considered to have the same priority as some level of mortality. A more sophisticated representation of morbidity in the workforce design model is precluded by the lack of a usable classification scheme for morbidity and data on the expected incidence of morbidity in wartime.

In Section IV, we describe our efforts to find data suitable for deriving penalty scores. Here, we provide several simplified examples to illustrate how the model uses the penalty scores to decide which patient conditions will be treated and which will not, when there are not enough physicians. The model also considers assigning a substitute physician; this assignment generaly carries a higher penalty than the assignment of the preferred provider, but a lower penalty than leaving the condition untreated. In the examples given here, we consider only a single bad outcome (mortality), two patient conditions, and one physician. The physician has only enough time to treat one of the two patient conditions.

The two guidelines for allocating scarce physician time (described above) dictate the following "rule": The physician should devote his limited time to patients where the provision of care by a physician (or trained extender personnel) will make the most difference—that is, avoid the worst outcomes. The "rule" is followed in the workforce design model by minimizing the total penalty score. However, perhaps counterintuitively, minimizing the total penalty score does not necessarily mean allocating time to the most serious conditions.

We have designed three simple cases to show how the allocation rule works. The first example (Case 1, summarized in Table 9) assumes that the two patient conditions require the same amount of physician treatment time. Condition A has a higher mortality rate, and consequently a higher penalty, than condition B does; A is obviously a more serious medical condition. However, we prefer to have the physician treat condition B because treatment reduces mortality by 5 percentage points (.07 – .02) for condition B, but only three points for condition

return to duty in wartime. We then use a system of weights to reflect the relative priority placed on each of the multiple wartime outcomes and on peacetime versus wartime outcomes.

In the remainder of this section, we outline the criteria represented by the penalty scores, give some simple examples to show how the penalty scores determine assignments, and explain how we use information provided by the model to calculate output-based measures of physician capability. Section IV describes the structure of the penalty scores in more detail and the penalty scores we developed to illustrate applications of the model. Both discussions focus on the wartime criteria and penalty scores. We did not develop peacetime penalty scores because current peacetime constraints severely limit the Air Force's flexibility to target its workforce to match the peacetime priorities that would be represented by the penalty scores. In contrast, the wider opportunities for specialty substitution in wartime introduce more flexibility to target wartime priorities. To apply the model to problems that impose less binding constraints would require peacetime penalties.

WARTIME MEDICAL GOALS: CRITERIA FOR ALLOCATING PHYSICIANS IN WARTIME

In planning for wartime scenarios, the Air Force medical service aims to treat as many casualties as possible. But recognizing that the wartime medical workload could exceed capacity, effective planning must be based on the priorities given to treating different types of casualties. These priorities reflect the relative values placed on three outcomes of wartime medical treatment: saving lives, decreasing morbidity, and quickly returning personnel to duty. Among dimensions of morbidity, the prevention of permanent disability is particularly important.

In this study, we are concerned with the ability to treat casualties within the theater of combat. Upon mobilization, within-theater care is the primary responsibility of active duty physicians because they can be deployed quickly; as reserve physicians become available, they fill in for the departed active duty physicians in U.S. military hospitals. Because we examine active duty physicians, the priorities we consider are those of the within-theater treatment system. These priorities reflect the importance to the Air Force of the different medical outcomes that can occur within the theater in addition to the likelihood of these outcomes. We have identified and quantified for use in the model outcomes that can be expected from prompt treatment by the preferred treater, from prompt treatment by a substitute specialist, and from a delay of treatment until the patient has been evacuated (usually, to the CONUS).

The Air Force medical readiness planning regulations (U.S. Air Force, 1981) describe the principles of disaster medicine to be followed in wartime. The description begins by recognizing that disaster medicine requires "a practice that differs considerably from the usual principles of patient care." The casualties should be triaged according to a system that assures the "greatest good can be given to the greatest number of persons in the shortest time, within the *means available*. . . . Triage will be oriented toward rapid return to duty, then to treatment and stabilization of patients for evacuation." Severe casualties who are not expected to survive even with treatment should not be treated at the expense of other patients whose prognoses are better. In light of these principles, we used the following guidelines to develop and quantify the outcomes that determine priorities.

1. Providers should be allocated to perform those tasks where a minute of the providers' time has the greatest effect on patient returns to duty, mortality, and morbidity.

The method we adopted establishes the same penalty for a minute of provider time on a particular patient condition, regardless of the task being performed. This penalty per minute does differ by assigned provider—preferred, substitute, none—because, as we've already described, the expected outcomes for patients with that condition depend on the provider type. We have defined the penalty per minute spent on any task for condition j as the total penalty for the condition divided by the total number of provider minutes needed to treat that condition.

$$\text{penalty per minute, condition } j = \frac{\text{total penalty, condition } j}{\text{total treatment time, condition } j}$$

The total penalty for task t, when performed for condition j, equals the penalty per minute for the condition multiplied by the number of minutes needed to perform that task.

$$\begin{array}{lcll} \text{total penalty,} & & \text{penalty per} & \text{task time,} \\ \text{task } t \text{ for} & = & \text{minute,} & \times \quad \text{task } t \\ \text{condition } j & & \text{condition } j & \end{array}$$

Another way of calculating the task penalties for a particular condition is to multiply the total condition penalty by the fraction of total provider time employed in the task. For example, a closed fracture of a facial bone other than the mandible requires 245 minutes of treatment time in theater, including 10 minutes to perform a maxillofaciary exam (4 percent of the total provider time) and 28 minutes to perform a closed reduction of the fracture (11 percent). For both tasks, the penalty incurred when a minute of task time cannot be assigned equals the total penalty for not treating this facial bone fracture divided by 245, the total treatment time. The total penalty for not performing the exam is set at 4 percent of the penalty for nontreatment; not reducing the fracture carries a penalty of 11 percent of the total penalty.

This method bases the consequences of delaying a task, measured by the no-provider penalty for that task, on the severity of the condition for which the task is being done. It does not attempt to estimate the differential contributions of individual tasks toward a successful outcome for a single condition. Instead, it assumes that all tasks required to treat a particular condition are equally necessary and carry penalties proportional to the amount of time they require. Similarly, the penalties per minute for assigning the tasks for a patient condition to the preferred providers do not vary. However, the penalties for assigning the tasks to substitutes do vary, depending on the ability of each substitute to perform each task.

To show how the per minute task penalties depend on the total condition penalty as well as the total treatment time, Table 12 calculates per minute task penalties for examples of three different patient condition types: one with high mortality, one with some morbidity, and a third with a high return to duty rate. Every task performed for each of the three conditions carries the same penalty per minute for a given type of provider. Here, we show the penalties per minute for the preferred provider and for no provider (fourth column). The last column shows the differences in the penalties when the tasks cannot be assigned to a provider, versus assignment to the preferred provider. These differences (and the differences when substitute providers are used) determine the assignments made by the model.

The first condition, open wound to the heart, has large total penalties, regardless of assignment. The large penalties occur because, even with treatment by the preferred provider, patients with this condition do not return to duty and may die. Still, the large per minute difference between treatment and nontreatment (104) shows that treatment saves lives. In the

Table 12

PENALTIES PER MINUTE FOR ALL TASKS REQUIRED BY DIFFERENT PATIENT CONDITIONS

Patient Condition	Mortality Rate	Return to Duty Rate	Total Penalty	Penalty per MD min.	Diff. in Penalty
Open wound, heart					
MD time = 763 min.					
without delay	.11	.00	110,600	145	104
with delay	.90	.00	190,100	249	
Closed fracture, spine, no cord damage					
MD time = 272 min.					
without delay	.00	.00	100,000	368	11
with delay	.03	.00	103,100	379	
Closed dislocation, shoulder					
MD time = 89 min.					
without delay	.00	1.00	0	0	181
with delay	.00	.85	16,100	181	

second case, closed fracture of the spine without spinal cord damage, patients cannot return to duty, but they also rarely die. The total penalties are somewhat lower than for the open heart wound. However, as evidenced by the per minute difference of only 11 units, treatment has a much smaller effect on outcomes for closed spinal fractures. This condition is less likely to be included in the workload assignments. The third case, closed dislocation of the shoulder, has smaller total penalties than the first two conditions did because patients with dislocated shoulders return to duty and do not die. Despite the smaller total penalties, the per minute difference attributed to treatment is large because the total physician treatment time required is small relative to the expected improvement in outcome.

Recall that, in developing a penalty scheme to demonstrate the workforce design methodology, we have given the same weight for a one percentage point change in the return to duty rate as we give to a one percentage point change in expected mortality. The per minute penalty associated with a one percentage point change in either outcome depends on the amount of physician time required to achieve the change. The three cases in Table 12 demonstrate an important implication of assuming equal weights for return to duty and mortality. Patients who can return to duty have conditions that take far less than the average time to treat. For all patients whose return to duty requires prompt treatment (e.g., the condition is

not self-limiting), the difference in the penalty per minute with treatment is fairly high. In our applications of the model, assuming equal weights meant that all the tasks for "return to duty" conditions would be performed.

PENALTIES FOR PROVIDER SPECIALTY SUBSTITUTION

Treating a patient with a substitute provider is better than not treating the patient at all and worse than having the preferred provider treat him. Therefore, the substitution penalty for any given patient condition lies somewhere been the treatment and nontreatment penalty score. The better the substitute, the closer the substitution penalty to the preferred treater penalty.

We have derived substitution penalties from the results of the Physician Wartime Capability Survey. Recall that each physician respondent assessed his own skill at performing specific wartime treatment tasks, taken from the Clinical Data Base, on a scale of one to seven. Each item on this scale represented a different level of training necessary for competency. To translate the responses into substitution penalties, we matched the training scale to a second scale representing levels of skill degradation as follows:

Survey Response	Skill Degradation (Percent)
1. I can do this comfortably now	0
2. Need a few procedures to brush up	10
3. 1–4 hour refresher course	25
4. 1–2 day refresher course	40
5. 3–10 day refresher course	75
6. 1–2 months training	85
7. Never	90

The degradation scale indicates where to place a substitute physician on a scale with the preferred provider at one end and no provider at the other end. A physician who responded that he would need a one to four hour refresher course to feel competent at performing a task is only "75 percent as good as" the preferred provider for that task. In this manner, we established a degradation measure for each physician respondent; the degradation measure used in calculating substitution penalties equaled the average for all respondents within the substitute specialty. The penalty when specialty s substitutes to perform task i for patients with condition j, P_{sij}, is calculated according to the formula:

$$P_{sij} = P_{pij} + a_{si} \times (P_{nij} - P_{pij})$$

where P_{pij} denotes the penalty when the preferred provider handles task i for patients with condition j, P_{nij} denotes the penalty when no provider is available, and a_{si} denotes the average response for physicians in specialty s regarding their performance of task i.

For the task thoracotomy and pleurotomy Table 13 illustrates skill degradations and per minute penalties for the preferred and substitute providers. The preferred provider is a thoracic surgeon and the substitutes are general surgeons and orthopedists. The skill degradation measures for each of these specialists are given in the top line. This task is required to treat several conditions in the Clinical Data Base, including open wound of the thorax with rib fracture and pneumohemothorax, and multiple fragment wounds to the chest and abdomen, with

Table 13

EXAMPLE OF SKILL DEGRADATION MEASURES AND PENALTY SCORES
(TASK: Thoracotomy and pleurotomy)

Preferred Provider:	First Substitute:	Second Substitute:	
thoracic surgeon	general surgeon	orthopedic surgeon	No Provider
SKILL DEGRADATION ASSESSMENTS			
0%	12%	48%	100%
PER MINUTE PENALTIES WITH 1ST CONDITION: Open wound of thorax with rib fracture and pneumohemothorax			
230	253	323	425
PER MINUTE PENALTIES WITH 2ND CONDITION: Multiple fragment wounds, chest and abdomen, with pneumohemothorax and penetrating, perforating wound of the liver			
155	168	207	263

pneumohemothorax and a penetrating, perforating wound of the liver. The penalties differ by condition because the expected mortality rates and required treatment times differ (patients with both conditions do not return to duty). The second condition causes higher rates of mortality and requires more treatment time; the net result is a lower penalty per minute.

The skill degradation measures, averaged for all respondents in a specialty, are included in Appendix E as part of the matrix of feasible substitutions by task.

V. APPLICATIONS OF THE WORKFORCE DESIGN METHODOLOGY

The applications we chose to make were designed to demonstrate different uses of the model and to provide information that could be used in the Surgeon General's current efforts to develop improved manpower plans for wartime. Of course, the results of our applications are subject to the limitations of the data inputs we used. The applications evaluate the effect of specialty substitution and different resource constraints on wartime capability. More specifically, they address the following questions:

1. Could specialty substitution in wartime significantly improve the capability of the current physician force?
2. Should changes be made in the current list of substitutes approved by the three services?
3. To maximize capability, which tasks should each specialty be prepared to perform in wartime?
4. How much training is needed to ensure that physicians in each specialty could competently carry out their wartime role?
5. Could the peacetime patient population occupy enough physicians, with the right skills, to perform expected wartime medical workloads?
6. Do current authorizations ceilings substantially decrease wartime capability?
7. What contributions to wartime capability do retired beneficiaries make?

The first four questions concern substitution. Questions 1–3 can be answered by solving the wartime capability version of the model, while limiting physician availability to the current active duty force and stipulating alternative substitution matrices. The last four questions concern the effect of resource constraints and require the full peacetime-wartime version of the model. We treat the patient population as a resource because we have introduced a constraint in the model requiring physicians to be fully utilized in peacetime.

SPECIALTY SUBSTITUTION AND WARTIME CAPABILITY

How could the Air Force make the best use in wartime of the skills that its physicians now have and where should these skills be enhanced? The purpose of the substitution analysis was to show how the workforce design model and survey results can be used to answer this question. The analysis was designed to estimate improvements in *current* wartime capability with substitution, to assess the value of changes in the current tri-service substitution matrix, to identify the most productive wartime assignments of different physician specialties, and to describe the level and content of new training programs in wartime skills.

The wartime capability version of the workforce design model selects optimal wartime workload assignments for a pre-specified physician workforce, in this case the active duty workforce as of September 30, 1983 (the FY1983 physician endstrength). On this date, there were 3671 physicians in the Air Force, but only 2019 fully trained physicians in the specialties included in the model. We added to this number 497 physician assistants and 143 nurse-anesthetists for a total of 2659 providers. As we described in Section I, we then split this total

between the European theater and other requirements. After deleting the other requirements, the physician workforce left for Europe was composed of 28 percent surgeons (including 9 percent gynecologists). In contrast, the European theater requires a considerably larger workforce with double the proportion of surgeons. Recall that the wartime capability version of the model used in this application drops the peacetime side and considers only how best to use a specified physician force in wartime. We solved this model for three substitution matrices:

1. A matrix with no substitutes, using the preferred providers specified in the tri-service matrix,
2. The tri-service matrix (including substitutes),
3. A revised matrix, based on the the results of the Physician Capability Survey.

The solution obtained under each alternative matrix estimates the maximum capability of the physicians, employing the most productive substitutions allowed under the matrix. A comparison of the three estimates highlights the improvements in capability that would result from a policy of wartime substitution and from adopting the revisions to the substitution matrix suggested by the survey. The specific specialty-task assignments selected by the model describe wartime roles for each specialty. Using the survey results, we could then estimate the level of training needed for each specialty-task assignment.

Revisions in the Substitution Matrix

Appendix E contains the tri-service substitution matrix for all tasks included in the workforce design model inputs and indicates the additions and deletions we made after reviewing the survey results. We have also noted those tasks where the survey results, translated into substitution penalties, changed the preferred provider. The only deletions were made for general surgeons and obstetricians. General surgeons indicated discomfort with most ophthalmic and neurological surgery. Similarly, the obstetricians did not feel sufficiently confident in their abilities to perform specific surgery on the liver, spleen, and other abdominal organs. However, we did add the general surgeons as substitutes for some other surgical specialties in the examination tasks. The additions for obstetricians included some exams and some emergency procedures (intubation, tracheostomy), simpler than the ones we deleted (debridement, escharotomy), and pre-operative and post-operative care.

As we expected, the emergency physicians became the preferred providers, rather than substitutes, for most emergency procedures. In addition, they showed themselves to be good candidates for performing initial assessments in place of the various surgical specialties. However, because the Air Force has so few emergency physicians, these results are currently of little more than academic interest.

We made the most extensive changes in the specialties of internal medicine and pediatrics. These specialists, whose role in the tri-service matrix is extremely limited or nonexistent, were included for numerous basic tasks, including: basic evaluation and routine patient management, pre-operative and post-operative care, and some emergency procedures. Family and general practitioners, already listed as substitutes in many straightforward tasks, were added to surgical exams, pre-operative and post-operative care, and (with a sizable penalty) delayed primary closure.

Table 14

EFFECTS OF SUBSTITUTION POLICY
ON WARTIME CAPABILITY

	Wartime Capability	
	Workload Index	Outcome Index
No substitution matrix	33	46
Tri-service matrix	51	64
Revised matrix	66	81

Wartime Capability

Table 14 shows physician wartime capability as measured by the workload and outcome indexes described in Section III. The workload index measures the percent of the full workload requirement that the physicians are capable of handling. The outcome index measures the percent of the maximum improvement in mortality and return to duty achievable by the physicians. Both capability indexes increase dramatically if the tri-service substitutions are adopted, but even further improvements are possible with the revised matrix.

Wartime Task Assignments

The improvement occurs because of more and better use of such peacetime specialties as obstetrics-gynecology, internal medicine, and pediatrics. Without substitution, these specialties can be used only for the limited number of patients requiring them. The model can assign only 4 percent of the ob-gyns, 36 percent of the internists, and none of the pediatricians (14 percent of the internists and pediatricians combined). As the first column in Table 15 shows, the tri-service matrix permits greater utilization of ob-gyns, but not internists and pediatricians. However, in the absence of better alternatives, the model assigned the ob-gyns some tasks (liver resection, splenectomy) that the survey results led us to delete from the set of feasible substitutions.

Task allocations under the revised matrix are shown in the second column. This matrix now permits full utilization of all physicians in the three specialties and the task assignments are consistent with the self-assessed skills of the physicians themselves.

Better utilization of peacetime specialties not only improves overall workload capability, it also allows the surgeons to focus on surgery instead of examinations, post-operative care, and administrative duties (Table 16).

Table 15

UTILIZATION AND TASK ASSIGNMENTS UNDER ALTERNATIVE SUBSTITUTION POLICIES, SUBSTITUTE SPECIALTIES

Assignment	Tri-service Matrix	Revised Matrix
I. Obstetrics-gynecology		
Time doing specialty tasks	40%	2%
Time doing substitute tasks		
follow-up after orthopedic surgery	--	58
colostomy/ileostomy	30	--
delayed primary closure	25	12
debridement	--	18
resection of liver	12	--
escharotomy	--	5
repair urinary bladder	4	--
thoracic exam	--	4
splenectomy	1	--
excision	1	--
Other	21	1
Unused time	21	0
II. Internal Medicine and Pediatrics		
Time doing specialty tasks	14	<1
Time doing substitute tasks		
general post-op care	--	48
prepare discharge summary	--	22
order/document treatments	--	12
assess/administer IVs	--	10
neurological assessment	--	5
Other	<1	3
Unused time	86	0

Staffing Options for Contingency Hospitals

Based on the results for the revised substitution matrix, we developed contingency hospital staffing options for general surgery, orthopedic surgery, neurosurgery, ophthalmology, thoracic surgery, and vascular surgery. These staffing options, which are reproduced in Appendix F, provide guidelines for assigning active duty physicians to contingency hospital units. The Air Force is making these assignments in peacetime to facilitate a smooth mobilization of medical manpower in event of war. So long as the Air Force does not have enough surgeons to staff all its planned contingency hospitals, the assignments should reflect the desired substitution policy. The staffing option tables provide the necessary information to do this—based on this particular model run.

Table 16

UTILIZATION AND TASK ASSIGNMENTS UNDER ALTERNATIVE SUBSTITUTION POLICIES, GENERAL AND ORTHOPEDIC SURGEONS
(Percent)

Surgeon Type	Tri-service Matrix	Revised Matrix
General		
General surgery	14	49
Substitute surgery	43	50
Exams/follow-up	37	1
Other	6	0
Orthopedic		
Orthopedic surgery	32	100
Exams/follow-up	58	0
Other	10	0

Training Implications

The revised substitution list eliminated all substitutions that the survey results indicate would require extensive training. However, the remaining substitutions, including the ones chosen by the model, do call for more limited training programs to ensure that the substitutes will be competent. Because the penalties incurred in the model for each substitution reflect the average training level indicated by the survey results, to some extent the model has traded off the training requirement with the benefit in lives saved and returns to duty in selecting among feasible substitutions. The model has chosen the substitutions that best repay an investment in training.

In Section II, we suggested training methods for many of the substitute tasks that we concluded from the survey results were feasible. For the reason just given, the model tended to select substitute task assignments (Table 15) that require only limited training. In Air Force hospitals that perform enough surgery, most of the training could be provided in the form of patient rounds or by allowing the substitute specialist to assist in the surgery or the pre- and post-operative care. This "on the job" training would probably be less expensive than formal courses and, if conducted on a regular basis, would maintain as well as teach the substitute skills. Without this regular practice, the potential substitutes would soon lose their newly acquired skills.

RESOURCE LEVELS AND WARTIME CAPABILITY

The effects of different authorizations and specialty supply levels can be described by solving the model at corresponding overall physician ceilings. For these applications of the full model, the solutions provide information for peacetime and wartime on: maximum capability given the penalty structure, peacetime and wartime workload assignments for each specialty,

substitutions used, and specialty mix. To measure the effect of changes in the peacetime patient population, we solve the model for the different peacetime workloads required to serve the different populations. To illustrate this application, we chose to evaluate a straightforward population change: elimination of all retired beneficiaries. The Surgeon General's Office had previously estimated physician requirements for an active duty only population from PRISM III, so we could easily specify the peacetime inputs for this problem. We therefore solved the model for three resource levels:

> *Case 1*: The peacetime workload is at the maximum level supported by the beneficiary population in Air Force facility catchment areas. No other constraints are imposed on the workforce solution.
>
> *Case 2*: The potential peacetime workload remains the same, but the workforce is constrained by both the level of authorizations and the supply ceilings estimated for surgical specialties and subspecialties.
>
> *Case 3*: The peacetime workload is limited to the levels necessary to serve active duty family members only; no retired beneficiaries are served. No other constraints are imposed.

In case 2, we used the FY1985 authorizations ceiling on total active duty physicians. From this, we deleted the PRISM I authorizations for radiologists, pathologists, and flight surgeons, and added the PRISM I authorizations for physician assistants and nurse-anesthetists. The share to be allocated to the European theate still represented fewer physicians than needed.

Case 2 also imposed supply constraints on surgical specialties and subspecialties. The upper limit for each specialty or subspecialty equaled the PRISM I authorization estimates for FY1988 that were prepared in November 1983. In all cases, these limits are well above current staffing levels and represent reasonably generous estimates of the maximum staffing that could be recruited into the Air Force and supported by Air Force facilities and support staffing levels. For example, at the end of FY1983, the Air Force had 192 general surgeons and 78 orthopedic surgeons; the supply ceilings we used were 311 and 158, respectively. Again, we calculated a fair share in each specialty for the European theater.

The full model uses workload estimates derived from PRISM III peacetime provider requirements estimates in the manner described in Section IV. We calculated the required peacetime workload inputs for our model from the PRISM III estimates presented to the Air Force's PRISM steering committee in February 1984. PRISM III estimates the requirements to serve *all* active duty beneficiaries living in the facilities' 40-mile catchment areas and *88 percent* of the retired beneficiaries in the same areas. Because the facilities actually are serving a smaller population, PRISM III provider requirements exceed current staffing levels in almost all specialties. The Surgeon General's Office also supplied us with a second set of PRISM III requirements estimates, based only on active duty beneficiaries; these are used to estimate the wartime capability that can be supported without the retired patient population.

Table 17 shows the estimated wartime capability for the three resource level cases, measured according to the workload and outcome scales. We use these estimates to compare capability at different resource levels. The absolute capability estimates are not necessarily accurate because they are based on an imprecise approximation to the wartime requirement and our analysis is conducted at a highly aggregate level rather than at the more accurate level of the individual wartime facility. Second, the solutions are determined by the peacetime constraints

Table 17

WARTIME CAPABILITY UNDER DIFFERENT PEACETIME RESOURCE CONSTRAINTS

Resource Constraint	Workload Index	Outcome Index	Surgeons as % of Workforce
Case 1: Enough providers for active duty and retired beneficiaries, *no* other constraints	99	93	30
Case 2: Enough providers for active duty and retired beneficiaries, *but with* authorizations and supply ceilings	76	83	31
Case 3: Enough providers only for active duty beneficiaries, *no* other constraints	65	82	31

on patient population, authorizations, and specialty supply ceilings and by the wartime priorities represented by the penalty scheme. In seeking a solution, the model has tried to meet wartime priorities, subject to these peacetime constraints; it has not tried to trade off wartime and peacetime priorities.

Several observations can be made regarding these results. First, the loss of retired beneficiaries represents a tighter constraint than the authorizations and supply ceilings do. The number of physicians that can be kept busy in peacetime without retired patients is lower than the number allowed under the authorizations and supply ceilings. Second, although the workforces in all three cases have the same proportion of surgeons, as we move from case 1 to case 3, the decrease in capability as measured by outcomes is far less than the decrease in the workload measure. The difference in the movement of the two capability measures occurs because, in the face of substantial losses in workload capability, the model finds a great deal of flexibility to reallocate providers to minimize the deterioration in outcomes. The outcome measure is lower only for case 1 and results from a scarcity of neurosurgeons to treat high-priority patients; neurosurgery is a highly specialized skill allowing little room for substitution.

The results from the model can be used to estimate the number of reserve surgeons and nonsurgeons that would be needed to fill the active duty shortages and bring the workforce up to full capability. We prepared such estimates, based on the results for cases 1 and 2. The estimates cover shortages in all wartime theaters and in other requirements for the provider specialties we have studied, but they incorporate the effects of substitution only in the European theater. The estimates are offered only for illustrative purposes and should not be considered definitive.

At current beneficiary population levels and without any other constraints (case 1), our results imply that 200 surgeons, but no nonsurgeons, would be needed immediately to augment the active duty workforce. Under the constraints imposed in case 2, the number of surgeons more than doubles to 500, and 500 nonsurgeons are also needed. In either case, there would be an additional reserve requirement for 400 surgical assistants, some of which could be filled by surgical residents. These reserve requirements are in addition to the regular reserve requirements to replace deployed active duty physicians and fill other wartime needs.

VI. EXTENSIONS OF THE DUAL-MISSION WORKFORCE DESIGN METHODOLOGY

The dual-mission workforce design methodology, including the model and survey, can be applied to a wide range of manpower policy problems in military medicine and, potentially, in other military occupations. We have designed the basic methodology and developed some of the model inputs, but further input development would be needed to realize the model's full potential and lend confidence to its results.

Our efforts have focused on the wartime data inputs. On the wartime side, the most obvious remaining tasks are to survey the remaining specialties and determine the model's sensitivity to parameters in the penalty scheme.

Eventually, if the Air Force develops training programs to support wartime substitution plans, it may be possible to validate the survey results by observing the physicians carry out their designated tasks (under supervision). Subject to the caveat that observations made in peacetime may not be valid in wartime, the substitutes' ability to follow established procedures without taking more time could be assessed.

In addition, further thought should be given to predicting mortality rates and return to duty rates under conditions of delayed treatment, and to characterizing and estimating morbidity. The Clinical Data Base, used extensively to derive model inputs, is continually undergoing revision and extension; over time, it will support more accurate and varied analyses.

The greatest amount of work remains to be done on the peacetime side. The dual-mission analysis could use meaningful measures of peacetime capabilities, reflecting peacetime priorities. The capability measure should include estimates of the costs of meeting various components of the peacetime workload in-house and estimates of CHAMPUS costs. It should also include the differential value to the patients of in-house versus CHAMPUS care because this value affects the level of real health benefits to military personnel. This peacetime capability measure would require more detailed data on beneficiary utilization than PRISM III now provides.

Also on the peacetime side, a companion model could be developed for predicting potential changes in the beneficiary user population and the effects of utilization due to benefits changes. The predictions from such a model could then be entered as inputs in the workforce design model to estimate the effects benefits changes would have on wartime capability.

If inputs were developed describing the task capabilities and net savings in personnel costs of reserve physicians, the model could be used to evaluate the mix of reserve and active duty physicians. Reserve physicians impose lower personnel costs, their mix of skills differ, and more of them will result in less in-house and more CHAMPUS care. If the proper data were available, the workforce design model could evaluate these tradeoffs. Of course, the evaluation should not extend to wartime requirements that, because of reserve mobilization times, should be filled by reserve physicians.

Even at the current stage of development, the model can lend itself to other applications than the ones we have made. The Clinical Data Base, which at first covered only the European theater, is being extended to other theaters. It would not be difficult to incorporate the new information and add nonpatient treatment tasks to the data sets we used. This would allow analysis of worldwide requirements (including or excluding reserve requirements and supply). Other applications would require even less effort. These include assessments of the

effect on workforce design of changing the important wartime parameters: priorities on saving lives and returning personnel to duty, the frequency of occurrence of patient conditions, and casualty rates. These assessments would tell wartime planners whether their plans need to be sensitive to these factors, or whether the requirements are more robust.

Appendix C

AIR FORCE PHYSICIAN WARTIME CAPABILITY SURVEY

INTERNIST (INTERNAL MEDICINE) AND PEDIATRICIAN VERSION

AF SURVEY CONTROL
NO. 83-52 EXPIRES
31 DECEMBER 1983

When you have completed this questionnaire, please put it in the enclosed postage-paid addressed envelope, and put it in the mail as soon as possible. Thank you.

|_|_|_|_| 1-4/

THIS QUESTIONNAIRE
TO BE FILLED OUT BY: _____

The pattern of skill differences for foreign medical graduates is mixed. Foreign-trained family practitioners are more comfortable with anesthesia and less comfortable with pre-op and post-op care. Foreign-trained internists are more confident of their wartime skills in many areas, and FMG pediatricians appear to be less confident. Among the surgeons, the FMGs evaluated their skills as higher in other surgical specialties or subspecialties. This result is consistent with comments made during our interviews that residency training in general surgery has narrowed over time, whereas foreign training has remained broader.

Almost all the internists, pediatricians, and surgeons are board certified or board eligible. The board certified or eligible family practitioner generally expresses a higher level of confidence in his wartime skills. Not surprisingly, osteopathic physicians believe themselves to be more adept at simple orthopedic tasks. Finally, we note that pediatricians indicated a higher skill level than internists did in triage, pre-op and post-op care, and Group B intake tasks.

For the Air Force, the important findings are the changes in skill assessments attributable to wartime training programs, trauma experience, and foreign training in surgery. The general training given in current wartime classes enhances skills, or at least promotes confidence, in nonsurgeons. However, for surgeons, training does not substitute for experience in trauma care. Many of the Air Force's young general surgeons are trained in military residency programs; these programs might reevaluate their training curriculum in light of the broad surgical skills needed in wartime.

Table B.5

REGRESSION COEFFICIENTS, GENERAL SURGERY

(N=105, t-statistics in parentheses)

	INTAKE	NEUR	EYE	ENT	CARD	THOR_A	ABDOM	UROL	ORTH_A	ORTH_B	FACIO
R	.2013	.1036	.0416	.1366	.2235	.1103	.0945	.0831	.1016	.0862	.1762
CONSTANT	1.291	4.27	4.084	2.894	1.449	1.851	1.413	1.864	4.263	2.573	4.616
	(4.04)	(6.28)	(6.51)	(7.10)	(2.60)	(2.57)	(2.36)	(3.69)	(5.57)	(6.07)	(5.87)
ENTR_AGE	.0256	-.0028	.0043	-.0120	.0339	.0295	.0165	.0079	-.0089	-.0085	-.0012
	(3.53)	(-0.18)	(0.31)	(1.30)	(2.67)	(1.80)	(1.21)	(0.69)	(-0.51)	(-0.88)	(-0.07)
YR_AFMED	.0019	-.01055	-.0064	-.0268	.0116	-.0274	-.0210	-.0103	.0416	-.0068	.0074
	(0.01)	(-0.35)	(-0.22)	(-1.48)	(0.47)	(-0.86)	(-0.79)	(-0.46)	(1.22)	(-0.36)	(0.21)
FMG	-.4019	-.6428	-.6227	-.5280	-.420	-.6686	-.0431	-.2964	-.6508	-.3604	-.5778
	(-2.46)	(-1.85)	(-1.92)	(-2.53)	(-1.47)	(-1.81)	(-0.14)	(-1.15)	(-1.66)	(-1.66)	(1.43)
W_CLASS	- 0938	.1223	.0530	-.1502	.1260	.2082	.2070	-.0951	.0564	-.0322	-.3799
	(-0.66)	(0.38)	(0.18)	(-0.79)	(0.48)	(0.62)	(0.74)	(-0.40)	(0.16)	(-0.16)	(-1.03)
TRAUM4	-.4422	-.8954	-.3325	-.5061	-1.080	.823	-.6275	-.6096	-.5770	-.4499	-.7982
	(-3.27)	(-3.12)	(-1.23)	(-2.94)	(-4.57)	(-2.89)	(-2.48)	(-2.85)	(-1.78)	(-2.51)	(-2.40)

Table B.4

REGRESSION COEFFICIENTS, INTERNAL MEDICINE AND PEDIATRICS

(N=324, t-statistics in parentheses)

	INTAKE_A	INTAKE_B	ANES	EYE_B	THOR_B	OP-CARE	ASSIST	TRIAGE
R	.0607	.1838	.0405	.0911	.1217	.0969	.0400	.1314
CONSTANT	4.059	1.706	4.256	3.666	2.438	1.925	3.486	3.636
	(11.9)	(9.37)	(11.07)	(7.17)	(7.80)	(6.12)	(5.55)	(8.62)
ENTR-AGE	-.0029	.0100	-.0147	.0051	.0063	0079	-.0031	-.0138
	(-0.28)	(1.84)	(-1.28)	(0.33)	(0.67)	(0.83)	(0.17)	(-2.10)
YR-ARMED	-.0100	.0134	.0080	-.0488	.0012	.0101	.0066	-.0482
	(-0.71)	(1.78)	(0.50)	(-2.31)	(0.09)	(0.78)	(0.26)	(-2.77)
PEDS	-.2750	-.4363	-.0126	-.3226	-.4673	-.5847	.2715	-.4887
	(-2.12)	(-6.27)	(-0.09)	(-1.65)	(-3.90)	(-4.86)	(1.13)	(-3.03)
FMG	-.3699	-.2829	-.2777	-.9015	-.3904	-.6435	-.4427	-.7858
	(-1.43)	(-2.05)	(-0.95)	(-2.32)	(-1.64)	(-2.69)	(-0.93)	(-2.45)
FMG-PEDS	.7080	.5999	.5889	1.532	1.000	.9543	-.3166	1.123
	(2.08)	(3.29)	(1.53)	(3.00)	(3.19)	(3.03)	(-0.50)	(2.66)
W-CLASS	-.1876	-.1375	.0811	.07728	-.3758	-.2103	-.2965	-.5562
	(-1.39)	(-1.90)	(0.53)	(-0.38)	(-3.02)	(-1.68	(-1.19)	(-3.31)
TRAUMA	-.4425	-.2664	-.4101	-.7940	-.4488	-.2784	-.4999	-.6412
	(-3.69)	(-4.15)	(-3.02)	(-4.40)	(-4.06)	(-2.51	(-2.26)	(-4.31)

Table B.3

REGRESSION COEFFICIENTS, FAMILY PRACTICE AND GENERAL PRACTICE
(N=224, t-statistics in parentheses)

	INTAKE_A	INTAKE_B	ANES	GEN_SURG	EYE-B	ENT	ORTH_B	OP-CARE
R	.2278	.3294	.1124	.1450	.1681	.1315	.1814	.1646
CONSTANT	3.193	1.350	1.146	5.358	2.804	6.117	4.454	2.089
	(10.2)	(8.48)	(5.90)	(11.5)	(7.60)	(13.17)	(10.8)	(5.91)
ENTR_AGE	.0171	.0234	.0154	-.0091	.0091	-.0181	-.0025	.0054
	(1.96)	(5.28)	(2.85)	(-0.70)	(0.89)	(-1.40)	(-0.22)	(0.54)
YR_AFMED	-.014	.0235	.0104	-.0543	-.0418	-.0198	-.0105	.0680
	(-0.66)	(2.12)	(0.77)	(-1.67)	(-1.63)	(-0.61)	(-0.37)	(2.76)
BOARDS	-.4539	-.1510	-.1775	.0425	-.5545	-.2648	-.1835	-.2975
	(-3.02)	(-1.98)	(-1.91)	(0.19)	(-3.13)	(-1.19)	(-0.93)	(-1.75)
OSTEOP	-.3664	-.0076	-.2170	-.5175	-.6366	-.5200	-.8249	.1525
	(-1.42)	(-0.06)	(-1.36)	(-1.35)	(-2.10)	(-1.36)	(-2.43)	(0.52)
FMG	.1097	.0677	-.3327	.0339	.0046	.6003	.4386	.5483
	(0.45)	(0.55)	(-2.20)	(0.09)	(0.02)	(1.66)	(1.36)	(1.99)
W_CLASS	-.5643	-.3536	-.1980	-.5085	-.4288	-.6600	-.5254	-.3468
	(-3.42)	(-4.21)	(-1.93)	-2.06)	(-2.20)	(-2.69)	(-2.42)	(-1.86)
TRAUM1	-.0378	-.1545	-.1173	.0647	-.1712	-.0101	-.0326	-.1191
	(-0.19)	(-1.54)	(-0.96)	(0.22)	(-0.74)	(-0.03)	(-.13)	(-0.53)
TRAUM2	-.3086	-.2688	-.183°	-.3265	-.2108	-.2297	-.6055	-.6310
	(-1.52)	(-2.61)	(-1.46)	-1.08)	(-0.88)	(-0.76)	(-2.26)	(-2.75)
TRAUM3	-.4200	-.4258	-.2911	-.5431	-.4851	-.5812	-.7507	-.1878
	(-1.53)	(-3.04)	(-1.71)	-1.32)	(-1.50)	(-1.42)	(-2.07)	(-0.60)
TRAUM4	-.7641	-.4023	-.1737	-1.075	-.6134	-.8299	-1.049	-.7556
	(-4.25)	(-4.40)	(-1.56)	(-4.01)	(-2.89)	(-3.11)	(-4.43)	(-3.72)

a negative effect on skill level, and a negative coefficient indicates a positive effect. Where entry age affects skill level, principally for intake procedures, the effect is negative but small. Air Force experience does not appreciably alter the surgeons' self-evaluated skills, but the specialists who have spent more time in the Air Force do report lower skills in intake tasks. The internists and pediatricians, however, seem to gain confidence in triaging and in simple eye procedures, perhaps because of the time they spend on call for the emergency room.

The training classes in wartime medicine are helpful across the board for family or general practitioners; helpful for internists and pediatricians only in general tasks such as examination, triage, and simple emergency procedures; and not helpful for general surgeons. By contrast, trauma experience, defined differently for the three specialty groups, gives all groups greater confidence in their skills. However, where the training classes do have an effect, they accomplish almost as much as actual experience.

Table B.2

VARIABLE MEANS
(Standard deviations)

Variable	Family and General Practice	Internal Med. & Pediatrics	General Surgery
INTAKE$A	2.59 (1.09)	3.42 (1.08)	1.74 (0.70)
INTAKE$B	1.56 (0.59)	1.59 (0.62)	
ANES	1.20 (0.63)	3.75 (1.20)	
GEN$SURG	4.12 (1.54)		
NEUR			3.60 (1.41)
EYE$A			4.55 (1.55)
EYE$B	1.88 (1.23)	2.89 (1.64)	2.19 (1.17)
ENT	4.56 (1.52)		1.84 (0.86)
CARD			2.10 (1.25)
THOR$A			2.20 (1.51)
THOR$B		1.88 (1.02)	
ABDOM			1.70 (1.24)
UROL			1.62 (1.04)
ORTH$A			3.79 (1.59)
ORTH$B	3.39 (1.39)		1.92 (0.87)
FACIO			3.80 (1.61)
OP$CARE	1.83 (1.18)	1.56 (1.02)	
ASSIST		3.05 (1.97)	
TRIAGE		1.96 (1.39)	
ENTR$AGE	28.8 (8.54)	27.8 (7.05)	32.6 (10.4)
YR$AFMED	4.49 (3.16)	5.65 (4.27)	5.84 (5.01)
BOARDS	0.679		
OSTEOP	0.071		
FMG	0.098	0.142	0.305
W$CLASS	0.799	0.728	0.733
TRAUM(1-3YR)	0.183	0.247	0.133
TRAUM(4-6YR)	0.161	0.077	0.143
TRAUM(7-11YR)	0.067	0.059	0.152
TRAUM(12+YR)	0.223	0.090	0.457
Number of Observations	224	324	105

these physicians, skill capabilities depended on the number of patients per year. Fewer than one-half of the internists and pediatricians had trauma experience, and of these one-half saw fewer than four trauma patients per year. Internists' and pediatricians' self-evaluated ability to perform wartime tasks depended on the presence, but not the level, of trauma experience. In contrast, almost 90 percent of the surgeons had recent trauma experience, many of them at the fairly high rate of one or more patients per month. The surgeons systematically rated their wartime skills at a higher level only if they had this more intensive trauma experience. Tables B.3 through B.5 present the regression coefficients (and t-statistics) for family and general practice, internal medicine and pediatrics, and general surgery. A positive coefficient indicates

Table B.1—continued

Procedures by Group (variable name)	Family Prac./ General Prac.	Internist/ Pediatrician	General Surgeon
Cardiovascular Surgery (CARD)			
suture and ligation, intra-abdominal vessels			x
venous anastomosis (intrathoracic)			x
cardiotomy/pericardiotomy			x
suture and ligation of heart and pericardium			x
anastomosis of peripheral vessels			x
Thoracic Surgery - Group A (THOR_A)			
thoracotomy and pleurotomy			x
lobectomy			x
Thoracic Surgery - Group B (THOR_B)			
thoracocentesis		x	
chest tube insertion		x	
Abdominal Surgery (ABD)			
hepatotomy			x
liver resection			x
pancreatectomy (partial)			x
Genitourinary Surgery (UROL)			
repair kidney			x
complete nephrectomy			x
repair/anastomosis of ureter			x
repair urinary bladder			x
repair open wound of penis			x
Orthopedic Surgery - Group A (ORTH_A)			
open reduction of fractures (4)			x
open reduction of dislocations (2)			x
Orthopedic Surgery - Group B (ORTH_B)			
closed reduction of fractures (2)	x		x
closed reduction of dislocations (2)	x		
debridement of compound fractures			x
application of traction/external fixation	x		x
amputations (2)			x
Faciomaxillary Surgery (FACIO)			
closed/open reduction of fractures (3)			x
Neurosurgery (NEUR)			x
craniotomy/craniectomy			x
burr holes			x
laminectomy w/debridement and repair			x
exploration and suture of peripheral nerve			x
neuroplasty of peripheral nerve			x
Pre-op and Post-op Care (OP_CARE)			
fluid management	x	x	
infection management	x	x	
First Assist in Surgery (ASSIST)		x	
Triage (TRIAGE)		x	

Table B.1

TASKS INCLUDED IN THE DEPENDENT VARIABLES, BY SPECIALTY GROUP

Procedures by Group (variable name)	Family Prac./ General Prac.	Internist/ Pediatrician	General Surgeon
Intake Procedures: Group A (INTAKE_A)			
emergency control of hemorrhage	x	x	
tracheostomy	x	x	
ENT exam	x	x	x
psychiatric exam		x	
orthopedic exam	x	x	x
faciomaxillary exam	x		x
neurosurgical exam	x	x	x
endoscopy		x	
core rewarming	x	x	x
Intake Procedures: Group B (INTAKE_B)			
intubation of airway	x	x	x
cardiocentesis/pericardiocentesis	x	x	x
assess fluid/electrolyte requirements	x	x	x
central venous line	x	x	x
interpret EKG	x	x	x
interpret x-rays	x	x	x
neurological exam	x	x	x
lumbar puncture	x	x	x
minor surgical procedure		x	
Anesthesia (ANES)			
local/area anesthesia	x	x	
general anesthesia		x	
General Surgery (GEN_SURG)			
major debridement	x		
delayed primary closure	x		
free skin grafts (2)	x		
Ophthalmic Surgery - Group A (EYE_A)			
orbitotomy			x
remove foreign body from eye structure			x
remove eyeball			x
suture cornea			x
scleroplasty and repair of sclera			x
Ophthalmic Surgery - Group B (EYE_B)			
remove foreign body from conjunctiva	x	x	
remove foreign body from cornea/sclera	x	x	
Ear, Nose, and Throat Surgery (ENT)			
excise external ear	x		x
reduce fracture of nasal bones	x		x
repair open neck wound	x		x

Appendix B

DO TRAINING AND EXPERIENCE AFFECT WARTIME CAPABILITIES?

The survey results measure perceived competency and confidence in acquiring new skills. We expected that training and experience in trauma medicine might enhance these perceived capabilities. However, older surgeons who had not had recent trauma experience might believe that their skills had deteriorated. To test our expectations, we estimated the effects on perceived capabilities of the following variables: civilian experience, military experience, board certification, trauma experience in the previous two years, foreign medical school training, participation in specific wartime medicine training courses, and current and previous military assignments by facility type. These effects were estimated separately for the different specialty groups using ordinary least squares regression techniques. Because of the small sample size, we did not estimate equations for emergency medicine physicians. The equations for obstetrician-gynecologists are not reported because the independent variables had no effect on the physicians' skill self-ratings. Separate regressions on the internal medicine and pediatrics samples gave similar results; here, we report only the equations estimated for the two specialty groups combined.

We estimated separate equations for groups of similar tasks. The dependent variables equal the summed responses for each task group; the task groups are listed in Table B.1. The intake, ophthalmic, thoracic, and orthopedic tasks fall into two groups: tasks that the respondents felt less competent to perform (labeled Group A), and tasks that they felt more competent to perform (labeled Group B). Because the surgeons did not clearly discriminate between the intake tasks we asked about, only one intake task group is defined for these specialists. The variable means and standard deviations are shown in Table B.2. The independent variables include age at entry into the Air Force (ENTR_AGE), years of service in Air Force medicine (YR_AFMED), and whether the physician is a foreign medical graduate (FMG). Two additional variables included only in the family or general practice regressions indicate if the physician is board certified (BOARDS) in family practice medicine or if he graduated from a school of osteopathic medicine (OSTEOP).

Air Force physicians can gain familiarity with wartime medicine in two ways. They can attend one of several wartime training programs, which include the practice of skills on mock casualties, or they can have treated actual trauma patients. The survey asked about attendance at several wartime medicine programs, which range in content from general discussion to specific lectures to mock casualty exercises to the hands-on training incorporated in the American College of Surgeons' Advanced Trauma Life Support Course. Although participation in any one of these programs adds to physicians' self-assessed capabilities, the effects did not differ by program. Therefore, one variable indicated participation in one or more of the programs (W_CLASS).

Actual experience in treating trauma patients has a larger effect on the physicians' evaluations. The amount of trauma experience is important, but the relationship between skills and trauma experience differs by specialty group. Over 60 percent of the family and general practitioners had some exposure to trauma patients within the previous two years. For

Table A.4

WARTIME DIAGNOSES TREATED IN AIR FORCE CONUS HOSPITALS, AVERAGE NUMBER PER HOSPITAL, 1980

Hospital Type	Category 1: Diagnoses Most Wartime Specific	Category 2: Diagnoses Less Wartime Specific
Hospitals	12	114
Regional hospitals	21	208
Medical centers	48	401
Wilford Hall Medical Center	164	1053

Table A.5

PEACETIME INCIDENCE OF MOST COMMON WARTIME SURGICAL PROCEDURES
(Air Force hospital inpatients, 1980)

Procedure	Wartime	Peacetime	
	Number/ 1000 Patients	Number/ 1000 Patients	Total Number Recorded
Debridement, compound fracture	277	--	--
Debridement, major w/anesthetic	124	--	--
Delayed primary closure	123	--	--
Craniotomy/craniectomy	103	0.7	189
Colostomy/ileostomy	96	0.8	232
Open cardiac massage	68	--	--
Repair neck wound	65	--	--
Thoractomy, pleurotomy	45	0.9	243
Amputation, upper leg	37	0.1	35
Repair kidney	33	0.3	95
Open reduction, maxilla/mandible	33	0.5	145
Open reduction, hand/finger/foot/toe	27	3.8	1049
Escharotomy w/o anesthesia	24	1.2	324
Resection, liver	22	0.1	23
Splenectomy	22	0.7	195

Table A.3

FREQUENCY OF WARTIME-SPECIFIC DIAGNOSES BY DIAGNOSTIC CLUSTER, CATEGORY 2: DIAGNOSES LESS SPECIFIC TO WARTIME

Cluster	Number	Percent
Skull fracture, closed, no hemorrhage	937	8.5
Skull fracture, open, no hemorrhage	89	0.8
Vertical column fracture	83	0.8
Fracture of ribs or sternum, open	1	0.0
Other central skeletal fracture, closed	192	1.7
Fracture to upper limb, open	165	1.5
Fracture to lower limb, open	168	1.5
Dislocation, open	5	0.0
Intracranial injury, closed, no hemorrhage	2376	21.6
Intracranial injury w/ hemorrhage after injury, no open wound	51	0.5
Injury to heart, no open wound	8	0.1
Laceration of eyelid, incl. full thickness	39	0.4
Open wound to ear, head	1367	12.4
Other open wounds, no complications	91	0.8
Open wound to forearm and hand, w/ complications	383	3.5
Open wound to lower limb, w/ complications	139	1.3
Injury to blood vessels of head, neck	2	0.0
Injury to blood vessels of thorax, abdomen, pelvis	18	0.2
Crushing injury	5	0.0
Burn confined to eye and adnexa	5	0.0
3rd degree burn	4	0.0
Injuries to optic and other cranial nerves	20	0.2
Injuries to spinal cords and other central nerves	18	0.2
Injuries to other peripheral and unspecified nerves	39	0.4
Shock	2	0.2
Myocardial infarction	1113	10.1
Cardiac arrest and arrhythmias	330	3.0
Respiratory disease, incl. infection, radiation	10	0.1
Respiratory failure, associated conditions	142	1.3
Bact/vir meningitis, encephalitis, rabies, gangrene	18	0.2
Other viral diseases	27	0.2
Parasitic diseases	35	0.3
Agranulocytosis	121	1.1
Psychiatric disorders	119	1.1
Plegia, paralysis, myoneural disorders	223	2.0
Other neurological disorders	217	2.0
Toxic effects	1	0.0
Effects of radiation	10	0.1
Effects of external causes, excl. radiation	5	0.0

Table A.2

FREQUENCY OF WARTIME-SPECIFIC DIAGNOSES BY DIAGNOSTIC CLUSTER, CATEGORY 1: DIAGNOSES MOST SPECIFIC TO WARTIME

Cluster	Number	Percent
Skull fracture, closed w/ hemorrhage	32	2.5
Fracture compromising respiratory system	11	0.8
Other central skeletal fracture, open	3	0.2
Closed intracranial injury, no hemorrhage	88	6.8
Open intracranial injury, no hemorrhage	19	1.5
Intracranial injury, w/ hemorrhage after injury, open wound	1	0.1
Internal injury, thorax, no open wound	23	1.8
Internal injury, thorax, open wound	46	3.5
Injury to heart. open wound	5	0.4
Injury to gastrointestinal tract, no open wound	48	3.7
Injury to gastrointestinal tract, open wound	26	2.0
Injury to other abdominal organs, no open wound	58	4.5
Injury to other abdominal organs, open wound	60	4.6
Injury to unspecified organs, no open wound	14	1.1
Injury to unspecified organs, open wound	5	0.4
Open wound of the ocular adnexa	49	3.8
Open wound of the eyeball	69	5.3
Open wound of the neck	49	3.8
Other open wound, no complications	261	20.1
Other open wound w/ complications	40	3.1
Open wound, multiple, to shoulder, arm, no complications	96	7.4
Open wound, multiple, to arm, shoulder, w/ complications	24	1.8
Traumatic amputation of finger/thumb	95	7.3
Traumatic amputation of arm/hand	3	0.2
Open wound, multiple, to lower limb, no complications	8	0.6
Open wound, multiple, to lower limb, w/ complications	20	1.5
Traumatic amputation of toes	12	0.9
Traumatic amputation of leg	6	0.5
Injury to blood vessels of extremities	30	2.3
Burn, 3rd degree, deep or loss of body part	1	0.1
Injuries to major peripheral nerves	96	7.4

Table A.1

PEACETIME INCIDENCE OF WARTIME DIAGNOSES
(Air Force hospital inpatients, 1980)

	Diagnoses Most Wartime Specific	Diagnoses Less Wartime Specific
Patients with primary diagnosis	667	7,494
Patients with secondary diagnosis	150	1,436
Total patients with diagnosis	817	8,930
Total diagnoses	1298	11,012
Total inpatient records reviewed	273,760	

procedures is small. These figures should be viewed with caution, however, because they may reflect substantial underreporting.

Research from the civilian sector has demonstrated a positive correlation between surgical volume and outcomes (Luft et al., 1979; Luft, 1980; Farber et al., 1981). For most of the specific procedures studied, hospitals that perform a larger volume display better outcomes, as measured by mortality rates or infection rates. The relationships appear to be logarithmic, implying that added experience yields the most significant benefit at lower volumes. In the most ambitious of these efforts, Luft (1980) found that although other factors (hospital size, size of teaching program, geographic location) contributed to the observed mortality rates, they did not affect the relationship between volume and outcome. For some procedures, experience with similar procedures appeared to affect mortality rates; but for other procedures, related experience had no effect. Luft's attempt to estimate a simultaneous equations model failed to settle the important question: Do outcomes improve with volume, or do hospitals with above-average expected outcomes attract a greater volume? Because many other questions about the underlying causes of this correlation between volume and outcome remain unanswered, we need to be cautious in drawing inferences from the research to date. We did conclude from the low incidence of wartime-related diagnoses and procedures in Air Force hospitals and the possibility that this low volume might adversely affect outcomes in wartime that a self-assessment by Air Force physicians of their skills would be useful.

Appendix A

CAN AIR FORCE PHYSICIANS PRACTICE WARTIME SKILLS IN PEACETIME?

Early in our analysis, we surveyed the Air Force's 1980 automated inpatient record file to see how often diagnoses and procedures of specific importance in wartime occur in peacetime. We focused on inpatients rather than outpatients primarily because such diagnoses would rarely be treated on an outpatient basis. Furthermore, detailed outpatient data are not available. The tri-service wartime Clinical Data Base includes a list of 309 patient conditions, developed for use in describing wartime caseloads. We coded these conditions, using the ICD-9 diagnostic coding system, to allow comparisons with the inpatient records. Many of the wartime conditions are described by multiple diagnoses; the individual diagnoses are frequently general diagnoses, which may take one of several specific forms. Therefore, we took all individual ICD-9 diagnoses and compiled a complete list of diagnoses related to one or more of the 309 wartime conditions. We then grouped these diagnoses into three categories according to the criteria: expected incidence in wartime, expected frequency and distribution across the population in peacetime, and degree of complexity. The categories are labeled: (1) most specific to wartime, (2) less specific to wartime, and (3) not specific to wartime. Thus, a diagnosis expected to occur frequently in wartime may be "demoted" from category 1 to category 2 if it occurs so commonly in peacetime, and with such general distribution, that we may reasonably assume widespread familiarity with and expertise in evaluating and treating the condition.

Table A.1 shows the total number of occurrences of the 228 diagnoses in category 1 and the 415 diagnoses in category 2. Reflecting the complexity of these diagnoses, many inpatient records listed multiple diagnoses. Not surprisingly, most records with a diagnosis in either category listed that diagnosis as primary. Considering both primary and secondary diagnoses, only 0.5 percent of these peacetime records listed any category 1 diagnosis and 4 percent listed any category 2 diagnosis. Tables A.2 and A.3 show the absolute and percentage frequencies of each cluster of related diagnoses in categories 1 and 2, respectively. Four clusters account for one-half of the patients in category 2; the distribution is somewhat more even in category 1. Table A.4 reports the average per month number of diagnoses in each category treated in CONUS hospitals. At these rates, very few Air Force surgeons get regular exposure to diagnoses similar to those presenting in wartime.

In this context, however, we are using diagnoses to proxy procedures. We initially concentrated on diagnoses because our interviews with the medical records librarians at several bases suggested that diagnostic information should be more complete and accurate. We did also survey the 1980 inpatient records to see how frequently procedures expected to be performed commonly in wartime are recorded in peacetime. The Clinical Data Base also includes a wartime task list, a subset of which is specified for each patient condition. Table A.5 lists the 15 most common wartime tasks, each expected to be performed more than 20 times per 1,000 patients, and the frequency with which they are recorded in the 1980 file. For all procedures, the peacetime rate is only a fraction of the wartime rate and the absolute number of

INSTRUCTIONS

PLEASE ANSWER ALL QUESTIONS BY FILLING IN THE BLANKS OR CIRCLING THE RESPONSE CODES AS INDICATED.

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a. This survey information is authorized for solicitation by Federal Statute Title 10, United States Code, Sections 133 and 8012, and Executive Order 9397, 22 November 1943.

b. Participation in this survey is voluntary.

c. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

CONFIDENTIALITY

Information which would permit identification of individuals will be used only for the purposes of the survey mail-out and follow-up. All information which would identify individuals will be deleted from survey materials.

PHYSICIAN SURVEY

PART I: PERSONAL CHARACTERISTICS QUESTIONS

1. In column A, list the Air Force Specialty (AFSC) codes indicating your medical specialties. If applicable, include subspecialty letter codes.
Page 3 contains a complete list of physician AFSC codes.

   In column B, indicate whether you are board-eligible or board-certified in each specialty.

	Column A	Column B			
	AFSC code	Board-Certified	Board-Eligible	Neither	
		(Check one)			
Primary specialty	☐☐☐☐☐	☐ 1	☐ 2	☐ 3	7-12/
Secondary specialty (if any)	☐☐☐☐☐	☐ 1	☐ 2	☐ 3	13-18
Tertiary specialty (if any)	☐☐☐☐☐	☐ 1	☐ 2	☐ 3	19-24

2. What is your duty AFSC code? ☐☐☐☐☐ 25-29

AIR FORCE SPECIALTY CODES

AFSC	AFS TITLE
9316	Staff Clinician
9346	Family Physician
9346A	Family Practice Specialist
9356	Aerospace Medical Physician
9356A	Aerospace Medical Specialist
9356B	Preventive Medicine
9356C	Occupational Medicine
9356D	Family Practice Specialist
9366	Pediatrician
9366A	Allergy
9366B	Adolescent Medicine
9366C	Cardiology
9366E	Endocrinology
9366F	Neonatology
9366G	Gastroenterology
9366H	Hematology
9366J	Neurology
9366L	Infectious Diseases
9366M	Medical Genetics
9366N	Nephrology
9376	Physical Medicine Physician
9386	Internist
9386A	Allergy
9386B	Oncology
9386C	Cardiology
9386E	Endocrinology
9386G	Gastroenterology
9386H	Hematology
9386J	Rheumatology
9386K	Pulmonary Diseases
9386L	Infectious Diseases
9386N	Nephrology
9386R	Nuclear Medicine
9396	Emergency Physician

AFSC	AFS TITLE
9416	Surgeon
9416A	Thoracic Surgery
9416B	Colon & Rectal Surgery
9416C	Cardiac Surgery
9416D	Pediatric Surgery
9416E	Peripheral Vascular Surgery
9416F	Neurological Surgery
9416G	Plastic Surgery
9426	Urologist
9436	Ophthalmologist
9446	Otorhinolaryngologist
9486	Orthopedic Surgeon
9486A	Hand Surgery
9486B	Pediatrics
9496	Obstetrician/Gynecologist
9496A	Endocrinology
9496B	Oncology
9496C	Pathology
9496D	Maternal-Fetal Medicine
9526	Pathologist
9526F	Neuropathology
9536	Diagnostic Radiologist
9536B	Neuroradiology
9536C	Nuclear Medicine
9536E	Special Procedures
9556	Dermatologist
9566	Anesthesiologist
9576	Neurologist
9586	Psychiatrist
9586A	Child Psychiatry
9596	Radiotherapist

3. a. Did you graduate from a medical school or college of osteopathic medicine?

Medical school..... 1 30/

College of osteopathic medicine..... 2

b. Where was the school located?

United States..... 1 31/

Canada..... 2

A foreign country..... 3

c. Specify the medical school or college of osteopathic medicine:

_____

d. In what year did you graduate?

| 1 | 9 | | | 32-33/

4. What type of internship (first post-graduate year) did you have?

Straight..... 1 34/

Mixed or rotating..... 2

5. How many years of residency training did you complete? (Include your internship year.)

Years | | 35/

6. a. Have you completed one or more fellowships?

Yes..... 1 36/

No..... 2

b. If YES, how many years of fellowship training did you complete?

Years | | 37/

(SPECIFY the field(s):_____)

CARD 01

7. Estimate the percent of time during your residency and fellowship training that you spent in each of the following:

Military hospital.....	____%	38-40/
Veterans Administration hospital.....	____%	41-43/
Large urban public hospital..... (e.g., a city or county hospital)	____%	44-46/
Community or voluntary hospital.....	____%	47-49/
Private hospital.....	____%	50-52/
Another type of hospital.....	____%	53-55/

(SPECIFY: _____)

8. Have you completed any other health training programs?

(Circle all that apply)

Public health (e.g., MPH).....	1	56/
Health or business administration.....	2	57/
Other (SPECIFY:_____).....	3	58/

9. Have you ever taught interns or residents?

(Circle all that apply)

Yes, in a civilian program.....	1	59/
Yes, in a military program.....	2	60/
No.....	3	61/

10. How many years did you practice medicine in the civilian community? (Enter '00' for none.)

Years |__|__| 62-63/

11. a. In what year did you first enter the military?

|1|9|__|__| 64-65/

b. In what year did you first enter the Air Force?

|1|9|__|__| 66-67/

CARD 01

12. Through which procurement program did you first enter the military?

Berry Plan or Draft	1	68/
Medical Education Program	2	
Reserve Officers Training Corps (ROTC)	3	
Volunteer Recruiting Program	4	
Armed Forces Health Professions Scholarship Program (AFHPSP)	5	
Uniformed Services University of the Health Sciences (USUHS)	6	
Other (SPECIFY:_____)	7	

13. a. How many years have you served in the military?

Years |__|__| 69-70/

b. How many years have you worked in clinical medicine in the Air Force?

Years |__|__| 71-72/

c. Are you still working in clinical medicine?

Yes, full-time	1	73/
Yes, but not full-time	2	
No, I haven't done so for the last ____ years	3	

74-75/

14. While serving as a military physician, what positions have you held?

CARD 02

(Circle all that apply)

Hospital Commander	1	7/
Director of Professional Services	2	8/
Chief of Service	3	9/
Clinical Consultant to the Surgeon General	4	10/
Other administrative (SPECIFY:_____)	5	11/
None of the above	6	12/

CARD 02

15. a. Where have you been stationed in the Air Force?

(Circle all that apply)

Overseas	1	13/
Medical center	2	14/
Regional hospital	3	15/
Hospital with 50 or more beds	4	16/
Hospital with fewer than 50 beds	5	17/
Clinic	6	18/

b. Right now, where are you stationed?

Overseas	1	19/
Medical Center	2	
Regional hospital	3	
Hospital with 50 or more beds	4	
Hospital with fewer than 50 beds	5	
Clinic	6	
Not in a treatment facility	7	

16. a. Have you ever treated combat casualties?

(Circle all that apply)

Yes, in the theater of combat	1	20/
Yes, outside the theater of combat	2	21/
No	3	22/

b. IF YES: For how many months?

Months |__|__| 23-24/

CARD 02

17. a. During your training, did you treat non-combat trauma patients? (In determining your answer, do not count minor mishaps.)

Yes, but not more than 3 per year..... 1 25/

Yes, 4-6 per year at most..... 2

Yes, 7-11 per year at most..... 3

Yes, more than 12 per year..... 4

No..... 5

b. Since you completed your training, have you treated non-combat trauma patients? (In determining your answer, do not count minor mishaps.)

Yes, but not more than 3 per year..... 1 26/

Yes, 4-6 per year at most..... 2

Yes, 7-11 per year at most..... 3

Yes, more than 12 per year..... 4

No..... 5

c. IF YES in 17b: How recently did you have this experience?

Years Ago |__|__| 27-28/

18. Have you ever attended any of the following?

(Circle all that apply)

Advanced Trauma Life-Saving Course..... 1 29/

Combat Casualty Care Course..... 2 30/

Medical Red Flag Exercise..... 3 31/

Battlefield Medicine Course..... 4 32/

None of the above..... 5 33/

19. How old were you on your last birthday?

Years Old |__|__| 34-35/

20. What is your sex?

Male..... 1 36/

Female..... 2

CARD 02

21. Are you a citizen of the United States?

Native-born citizen..... 1 37/

Naturalized citizen..... 2

Not a citizen..... 3

22. What is your military rank?

0-3..... 1 38/

0-4..... 2

0-5..... 3

0-6..... 4

0-7 thru 0-10..... 5

23. At present, how many more years do you plan to remain in the Air Force?

Years |__|__| 39-40/

PART II: TASK PERFORMANCE QUESTIONS

Consider the early days of a conflict that breaks out without sufficient warning to fully mobilize Reserve physicians and draft civilian physicians. In this situation, certain specialties might be in short supply. If you were assigned to a medical support hospital located in a combat theater, which of the following clinical tasks would you be able to perform?

Some of the tasks listed below would normally fall to a physician in your specialty, but may be rarely performed in peacetime. Other tasks would usually be performed by other specialists; however, if the appropriate specialists were unavailable, substitutes would have to perform the tasks.

For each task listed below, CIRCLE the response that best characterizes the preparation you would need to perform that task.

1 - I can do this COMFORTABLY NOW.
2 - I can do this now, but it would TAKE A FEW PROCEDURES to get me up to speed.
3 - I could do this after a 1-4 HOURS refresher course.
4 - I could do this after a 1-2 DAYS refresher course.
5 - I could do this after 3-10 DAYS of training.
6 - I could do this after 1-2 MONTHS of training.
7 - I would NEVER see myself doing this.

CIRCLE ONLY ONE RESPONSE FOR EACH TASK	COMFORTABLY NOW	TAKE A FEW PROCEDURES	1-4 HOURS REFRESHER COURSE	1-2 DAYS REFRESHER COURSE	3-10 DAYS TRAINING	1-2 MONTHS TRAINING	NEVER	
A. EMERGENCY PROCEDURES								
Emergency surgical control of hemorrhage	1	2	3	4	5	6	7	41/
Intubation of airway	1	2	3	4	5	6	7	42/
Tracheostomy	1	2	3	4	5	6	7	43/
Cardiocentesis and Pericardiocentesis	1	2	3	4	5	6	7	44/

CARD 02

CIRCLE ONLY ONE RESPONSE FOR EACH TASK	COMFORTABLY NOW	TAKE A FEW PROCEDURES	1-4 HOURS REFRESHER COURSE	1-2 DAYS REFRESHER COURSE	3-10 DAYS TRAINING	1-2 MONTHS TRAINING	NEVER	
Assess fluid and electrolyte requirements	1	2	3	4	5	6	7	45/
Insert central venous line	1	2	3	4	5	6	7	46/
Interpret electrocardiogram	1	2	3	4	5	6	7	47/
Interpret X-rays	1	2	3	4	5	6	7	48/
Perform (specialist) ENT exam	1	2	3	4	5	6	7	49/
Perform (specialist) neurological exam	1	2	3	4	5	6	7	50/
Perform (specialist) psychiatric exam	1	2	3	4	5	6	7	51/
Perform (specialist) orthopedic exam	1	2	3	4	5	6	7	52/
Perform (specialist) neurosurgical exam	1	2	3	4	5	6	7	53/
Perform endoscopy (other than proctoscopy) such as gastroscopy	1	2	3	4	5	6	7	54/
Perform lumbar puncture	1	2	3	4	5	6	7	55/

CARD 02

CIRCLE ONLY ONE RESPONSE FOR EACH TASK	COMFORTABLY NOW	TAKE A FEW PROCEDURES	1-4 HOURS REFRESHER COURSE	1-2 DAYS REFRESHER COURSE	3-10 DAYS TRAINING	1-2 MONTHS TRAINING	NEVER	
Perform minor surgical procedure (including debridement of minor second degree burns, suture of lacerations, incision-and-drainage of skin and subcutaneous tissue)	1	2	3	4	5	6	7	56/
Administer core rewarming procedure	1	2	3	4	5	6	7	57/
B. ANESTHETIC PROCEDURE								
Induce general anesthesia	1	2	3	4	5	6	7	58/
Administer local/area anesthesia	1	2	3	4	5	6	7	59/
C. OPHTHALMIC SURGERY								
Removal of foreign body from conjunctiva (without magnet)	1	2	3	4	5	6	7	60/
Removal of foreign body from cornea or sclera	1	2	3	4	5	6	7	61/
D. THORACIC SURGERY								
Thoracocentesis (thoracic centesis)	1	2	3	4	5	6	7	62/
Chest tube insertion	1	2	3	4	5	6	7	63/

CARD 02

CIRCLE ONLY ONE RESPONSE FOR EACH TASK	COMFORTABLY NOW	TAKE A FEW PROCEDURES	1-4 HOURS REFRESHER COURSE	1-2 DAYS REFRESHER COURSE	3-10 DAYS TRAINING	1-2 MONTHS TRAINING	NEVER	
E. ABDOMINAL SURGERY								
Debridement of abdominal wall and peritoneum	1	2	3	4	5	6	7	64/
F. OTHER PROCEDURES								
Fluid management during pre- and post-op period	1	2	3	4	5	6	7	65/
Infection management during pre- and post-op period	1	2	3	4	5	6	7	66/
First-assist in surgery	1	2	3	4	5	6	7	67/
Perform triage	1	2	3	4	5	6	7	68/

THANK YOU FOR YOUR COOPERATION.

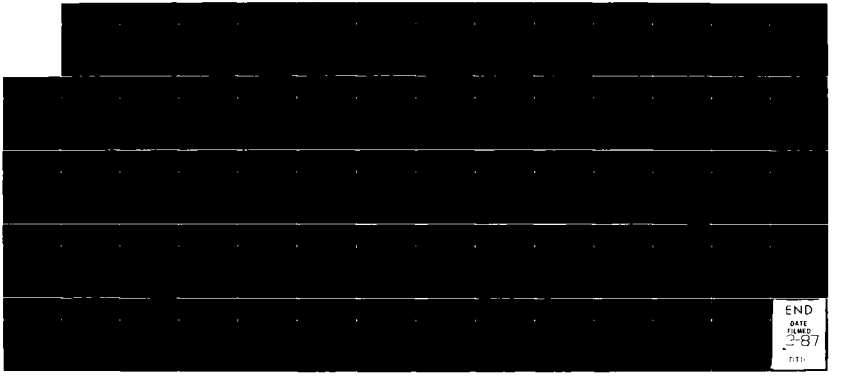
CARD 02

SUGGESTED TASK LISTS FOR PHYSICIAN SURVEY, BY SPECIALTY

What are the specialty substitution possibilities in early wartime? We would like physicians to evaluate a variety of tasks for possible specialty substitution. "Substitution" refers to tasks in other specialties, where the respondent could substitute. (It might also refer to tasks within the respondent's specialty, where other specialists could substitute.) In thinking about cross-specialty utilization to meet specialty requirements, we are looking for individuals who have similar skills-- without additional training, or with reasonable amounts of additional training. We wish to direct our attention toward certain specialty groups by presenting a small number of different task lists. We hope to identify specialties where there are some people available to perform other tasks-- tasks that will be important or common enough during wartime to warrant diverting specialists. We also need to know if specialists feel uncomfortable with some of the tasks which are assumed to lie within their competence.

How did we decide which tasks would appear as part of the selection? We considered the discrepancies in Army and Air Force task assignment to various specialists; the discrepancies in Army and Air Force opinion on "primary tasks" versus "substitution tasks"; tasks on which the Air Force and Army disagreed in a nontrivial medical way about the order of preference of various specialists-- the Clinical Data Base memorandum of 12 March 1982; the expressed opinions from our onsite interviews over certain tasks which certain providers should or should not do; the spectrum of tasks ranging from surely feasible to surely impossible for a given specialist; and "clinical judgment," as it is usually called. We may also wish to pay attention to the estimated frequencies of conditions, as shown in the right-hand columns of the Patient Condition List.

AD-A159 272 RECONCILING AIR FORCE PHYSICIANS' PEACETIME AND WARTIME 2/2
CAPABILITIES DEMO..(U) RAND CORP SANTA MONICA CA
S D HOSEK ET AL. AUG 85 RAND/R-3202-AF F49620-82-C-0018
UNCLASSIFIED F/G 6/5 NL



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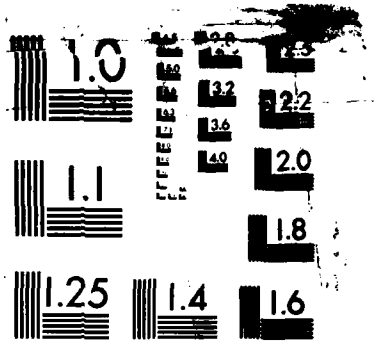

GENERAL SURGEON

Emergency Procedures
intubation of airway B6
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42
perform lumbar puncture B48
administer core rewarming procedure B59

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
laminectomy with debridement and repair of spinal cord,
cauda equina or meninges J10
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
orbitotomy J15
removal of foreign body from eye structure J16
removal of eyeball J17
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Cardiovascular Surgery
suture and ligation, intra-abdominal vessels J30
venous anastomosis, intrathoracic J32
cardiotomy and pericardiotomy J33
suture and ligation of heart and pericardium J34

anastomosis of peripheral vessels J37

Thoracic Surgery
thoracotomy and pleurotomy J38
lobectomy (partial pneumonectomy) J41

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
hepatotomy J48
liver resection J49
pancreatectomy (partial) J51
splenectomy J52
resection (partial) of colon J56
colostomy or ileostomy J57
intestinal anastomosis J58
repair operation on rectum/anus J60

Genitourinary Surgery
repair of kidney (suture wounds) J65
nephrectomy, complete J64
repair/anastomosis of ureter J66
repair urinary bladder J68
repair open wound penis J72

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
closed reduction, fracture of wrist, elbow, shoulder,
knee, fibula, clavicle J89
closed reduction, fracture of humerus, radius, ulna J901(sic)
open reduction with internal fixation of fracture of
fibula, clavicle J92
open reduction with internal fixation of fracture of ankle J93
open reduction of fracture of hand, finger, foot, toe J941(sic)
open reduction with internal fixation of fracture of elbow,
shoulder, knee J96
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation through lower leg J101
closed reduction of dislocation of shoulder J105 (part)
closed reduction of dislocation of elbow, wrist, knee, ankle J105 (part)
open reduction of dislocation of finger/thumb or toe J108
open reduction of dislocation of knee or shoulder J110
tendon repair J113A

Facio-Maxillary Surgery
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
fluid management during pre- and post-op period
infection management during pre- and post-op period

FAMILY PRACTITIONER AND GENERAL PRACTITIONER

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42
perform lumbar puncture B48
administer core rewarming procedure B59

Anesthetic Procedures
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
removal of foreign body from eye structure J16
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Cardiovascular Surgery
suture and ligation, intra-abdominal vessels J30
anastomosis of peripheral vessels J37

Thoracic Surgery
thoracotomy and pleurotomy J38

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46
splenectomy J52
resection (partial) of colon J56
colostomy or ileostomy J57
intestinal anastomosis J58
repair operation on rectum/anus J60

Genitourinary Surgery
repair of kidney (suture wounds) J65
nephrectomy, complete J64
repair/anastomosis of ureter J66
repair urinary bladder J68
repair open wound penis J72

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
closed reduction, fracture of wrist, elbow, shoulder,
knee, fibula, clavicle J89
closed reduction, fracture of humerus, radius, ulna J901(sic)
open reduction with internal fixation of fracture of
fibula, clavicle J92
open reduction with internal fixation of fracture of ankle J93
open reduction of fracture of hand, finger, foot, toe J941(sic)
open reduction with internal fixation of fracture of elbow,
shoulder, knee J96
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation through lower leg J101
closed reduction of dislocation of shoulder J105 (part)
closed reduction of dislocation of elbow, wrist, knee, ankle J105 (part)
open reduction of dislocation of finger/thumb or toe J108
open reduction of dislocation of knee or shoulder J110
tendon repair J113A

Facio-Maxillary Surgery
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
fluid management during pre- and post-op period
infection management during pre- and post-op period

OBSTETRICIAN/GYNECOLOGIST

Emergency Procedures
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret x-rays B18
perform (specialist) ENT exam B30
perform (specialist) orthopedic exam B40
perform (specialist) neurosurgical exam B42
perform lumbar puncture B48
administer core rewarming procedure B59

Anesthetic Procedures
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3

Neurosurgery
burr holes J8
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
orbitotomy J15
removal of foreign body from eye structure J16
removal of eyeball J17
removal of foreign body from cornea or sclera J19

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Cardiovascular Surgery
suture and ligation, intra-abdominal vessels J30
venous anastomosis, intrathoracic J32
cardiotomy and pericardiotomy J33
suture and ligation of heart and pericardium J34
anastomosis of peripheral vessels J37

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

thoracotomy and pleurotomy J38
lobectomy (partial pneumonectomy) J41

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
hepatotomy J48
liver resection J49
pancreatectomy (partial) J51
splenectomy J52
resection (partial) of colon J56
colostomy or ileostomy J57
intestinal anastomosis J58
repair operation on rectum/anus J60

Genitourinary Surgery
repair of kidney (suture wounds) J65
nephrectomy, complete J64
repair/anastomosis of ureter J66
repair urinary bladder J68
repair open wound penis J72

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
tendon repair J113A

Other Procedures (task number not listed)
fluid management during pre- and post-op period
infection management during pre- and post-op period

UROLOGIST

Emergency Procedures
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
perform (specialist) orthopedic exam B40
perform (specialist) neurosurgical exam B42
perform lumbar puncture B48

Anesthetic Procedures
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22

Cardiovascular Surgery
suture and ligation, intra-abdominal vessels J30
venous anastomosis, intrathoracic J32
suture and ligation of heart and pericardium J34
anastomosis of peripheral vessels J37

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40
thoracotomy and pleurotomy J38
lobectomy (partial pneumonectomy) J41

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46
hepatotomy J48
liver resection J49
pancreatectomy (partial) J51
splenectomy J52
resection (partial) of colon J56
colostomy or ileostomy J57
intestinal anastomosis J58
repair operation on rectum/anus J60

Genitourinary Surgery

repair of kidney (suture wounds) J65
nephrectomy, complete J64
repair/anastomosis of ureter J66
repair urinary bladder J68
repair open wound penis J72

Orthopedic Surgery
debridement of compound fracture J86
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
tendon repair J113A

Other Procedures (task number not listed)
fluid management during pre- and post-op period
infection management during pre- and post-op period

HEAD-AND-NECK (ENT) SURGEON

Emergency Procedures
intubation of airway B6
tracheostomy B7 (also see J27)
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42

Anesthetic Procedures
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
laminectomy with debridement and repair of spinal cord,
cauda equina or meninges J10
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
orbitotomy J15
removal of foreign body from eye structure J16
removal of eyeball J17
vitreal-retinal surgery J18
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Cardiovascular Surgery
anastomosis of peripheral vessels J37

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46
splenectomy J52
resection (partial) of colon J56
colostomy or ileostomy J57
intestinal anastomosis J58

Genitourinary Surgery
repair open wound penis J72

Orthopedic Surgery
debridement of compound fracture J86
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
tendon repair J113A

Facio-Maxillary Surgery
repair of jaw fracture with inert substances J114
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
open reduction of fracture of malar bone, zygoma/zygomatic arch J117
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
cosmetic lid surgery

PLASTIC SURGEON

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
laminectomy with debridement and repair of spinal cord, cauda equina or meninges J10
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
orbitotomy J15
removal of foreign body from eye structure J16
removal of eyeball J17
vitreal-retinal surgery J18
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Cardiovascular Surgery
anastomosis of peripheral vessels J37

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

INTERNIST (INTERNAL MEDICINE) AND PEDIATRICIAN

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) psychiatric exam B32
perform (specialist) orthopedic exam B40
perform (specialist) neurosurgical exam B42
perform endoscopy (other than proctoscopy) such as gastroscopy B47
perform lumbar puncture B48
perform minor surgical procedure (including debridement of
minor second degree burns, suture of lacerations,
incision-and-drainage of skin and subcutaneous tissue) B57
administer core rewarming procedure B59

Anesthetic Procedures
induce general anesthesia H2
administer local/area anesthesia H4

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
removal of foreign body from cornea or sclera J19

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Abdominal Surgery
debridement of abdominal wall and peritoneum J45

Other Procedures (task number not listed)
fluid management during pre- and post-op period
infection management during pre- and post-op period
first-assist in surgery
perform triage

debridement of compound fracture J86
tendon repair J113A

Other Procedures (task number not listed)
first-assist in surgery
perform triage
cosmetic lid surgery

DERMATOLOGIST

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) orthopedic exam B40
perform (specialist) neurosurgical exam B42
perform minor surgical procedure (including debridement of minor second degree burns, suture of lacerations, incision-and-drainage of skin and subcutaneous tissue) B57

Anesthetic Procedures
induce general anesthesia H2
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
removal of foreign body from eye structure J16
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
repair open wound of neck structures, whether superficial or deep J26

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Abdominal Surgery
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46

Genitourinary Surgery
repair open wound penis J72

Orthopedic Surgery

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46
splenectomy J52

Genitourinary Surgery
repair of kidney (suture wounds) J65
nephrectomy, complete J64
repair open wound penis J72

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
    without manipulation for reduction J88
closed reduction, fracture of wrist, elbow, shoulder,
    knee, fibula, clavicle J89
closed reduction, fracture of ankle, tibia, femur J90
closed reduction, fracture of humerus, radius, ulna J901(sic)
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
closed reduction of dislocation of finger/thumb or toe J104
closed reduction of dislocation of shoulder J105 (part)
closed reduction of dislocation of elbow, wrist, knee, ankle J105 (part)
tendon repair J113A

Facio-Maxillary Surgery
repair of jaw fracture with inert substances J114
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
closed reduction of fracture of maxilla/mandible J118

Other Procedures (task number not listed)
fluid management during pre- and post-op period
infection management during pre- and post-op period
first-assist in surgery

EMERGENCY MEDICINE SPECIALIST

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) psychiatric exam B32
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42
perform endoscopy (other than proctoscopy) such as gastroscopy B47
perform lumbar puncture B48
administer core rewarming procedure B59

Anesthetic Procedures
induce general anesthesia H2

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3

Neurosurgery
burr holes J8
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
removal of foreign body from eye structure J16
removal of eyeball J17
removal of foreign body from cornea or sclera J19
suture of cornea J20

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Cardiovascular Surgery
suture and ligation, intra-abdominal vessels J30
venous anastomosis, intrathoracic J32
cardiotomy and pericardiotomy J33
anastomosis of peripheral vessels J37

Other Procedures (task number not listed)
first-assist in surgery
cosmetic lid surgery

OPHTHALMOLOGIST

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
assess fluid & electrolyte requirements B11 (part)
interpret electrocardiogram B16
interpret x-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
laminectomy with debridement and repair of spinal cord,
cauda equina or meninges J10
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
orbitotomy J15
removal of foreign body from eye structure J16
removal of eyeball J17
vitreal-retinal surgery J18
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
tendon repair J113A

thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
tendon repair J113A

Other Procedures (task number not listed)
first-assist in surgery
cosmetic lid surgery

NEUROSURGEON

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
assess fluid & electrolyte requirements B11 (part)
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401

Anesthetic Procedures
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
laminectomy with debridement and repair of spinal cord, cauda equina or meninges J10
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
orbitotomy J15
removal of foreign body from eye structure J16
removal of eyeball J17
vitreal-retinal surgery J18
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Cardiovascular Surgery
anastomosis of peripheral vessels J37

Thoracic Surgery

open reduction with internal fixation of fracture of wrist, humerus, femur, tibia, radius, ulna J94
open reduction of fracture of hand, finger, foot, toe J941(sic)
open reduction with internal fixation of fracture of elbow, shoulder, knee J96
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
closed reduction of dislocation of finger/thumb or toe J104
closed reduction of dislocation of shoulder J105 (part)
closed reduction of dislocation of elbow, wrist, knee, ankle J105 (part)
open reduction of dislocation of finger/thumb or toe J108
open reduction of dislocation of wrist or elbow J109
open reduction of dislocation of knee or shoulder J110
tendon repair J113A

Facio-Maxillary Surgery
repair of jaw fracture with inert substances J114
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
open reduction of fracture of malar bone, zygoma/zygomatic arch J117
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
first-assist in surgery
perform triage

PODIATRIST

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) neurosurgical exam B42
perform lumbar puncture B48
perform minor surgical procedure (including debridement of minor second degree burns, suture of lacerations, incision-and-drainage of skin and subcutaneous tissue) B57

Anesthetic Procedures
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ear, Nose, and Throat Surgery
reduction of fracture of nasal bones J25

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation, without manipulation for reduction J88
closed reduction, fracture of wrist, elbow, shoulder, knee, fibula, clavicle J89
closed reduction, fracture of ankle, tibia, femur J90
closed reduction, fracture of humerus, radius, ulna J901(sic)
open reduction with internal fixation of fracture of fibula, clavicle J92
open reduction with internal fixation of fracture of ankle J93

debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
closed reduction, fracture of wrist, elbow, shoulder,
knee, fibula, clavicle J89
closed reduction, fracture of ankle, tibia, femur J90
closed reduction, fracture of humerus, radius, ulna J901(sic)
open reduction with internal fixation of fracture of
fibula, clavicle J92
open reduction with internal fixation of fracture of ankle J93
open reduction with internal fixation of fracture of wrist,
humerus, femur, tibia, radius, ulna J94
open reduction of fracture of hand, finger, foot, toe J941(sic)
open reduction with internal fixation of fracture of elbow,
shoulder, knee J96
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
closed reduction of dislocation of finger/thumb or toe J104
closed reduction of dislocation of shoulder J105 (part)
closed reduction of dislocation of elbow, wrist, knee, ankle J105 (part)
open reduction of dislocation of finger/thumb or toe J108
open reduction of dislocation of wrist or elbow J109
open reduction of dislocation of knee or shoulder J110
tendon repair J113A

Facio-Maxillary Surgery
repair of jaw fracture with inert substances J114
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
open reduction of fracture of malar bone, zygoma/zygomatic arch J117
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
first-assist in surgery

ORTHOPEDIST

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42
perform lumbar puncture B48
perform minor surgical procedure (including debridement of minor second degree burns, suture of lacerations, incision-and-drainage of skin and subcutaneous tissue) B57

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8
laminectomy with debridement and repair of spinal cord, cauda equina or meninges J10
exploration and suture of peripheral nerve J11-J12
neuroplasty of peripheral nerve J13

Ear, Nose, and Throat Surgery
reduction of fracture of nasal bones J25

Cardiovascular Surgery
suture and ligation, intra-abdominal vessels J30
venous anastomosis, intrathoracic J32
anastomosis of peripheral vessels J37

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46

Orthopedic Surgery

Abdominal Surgery
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46
repair operation on rectum/anus J60

Genitourinary Surgery
repair open wound penis J72

Orthopedic Surgery
debridement of compound fracture J86
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
tendon repair J113A

Facio-Maxillary Surgery
repair of jaw fracture with inert substances J114
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
open reduction of fracture of malar bone, zygoma/zygomatic arch J117
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
perform triage
cosmetic lid surgery

PSYCHIATRIST

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) neurosurgical exam B42
perform minor surgical procedure (including debridement of minor second degree burns, suture of lacerations, incision-and-drainage of skin and subcutaneous tissue) B57
administer core rewarming procedure B59

Anesthetic Procedures
induce general anesthesia H2
administer local/area anesthesia H4

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Other Procedures (task number not listed)
first-assist in surgery
perform triage

PHYSICIAN'S ASSISTANT AND NURSE PRACTITIONER

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
cardiocentesis and pericardiocentesis B9
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) psychiatric exam B32
perform (specialist) orthopedic exam B40
perform (specialist) oral (facillomaxillary) exam B401
perform (specialist) neurosurgical exam B42
perform lumbar puncture B48
perform minor surgical procedure (including debridement of
minor second degree burns, suture of lacerations,
incision-and-drainage of skin and subcutaneous tissue) B57
administer core rewarming procedure B59

Anesthetic Procedures
induce general anesthesia H2
administer local/area anesthesia H4

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
removal of foreign body from eye structure J16
removal of foreign body from cornea or sclera J19

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Abdominal Surgery
debridement of abdominal wall and peritoneum J45

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
closed reduction, fracture of wrist, elbow, shoulder,
knee, fibula, clavicle J89
closed reduction, fracture of ankle, tibia, femur J90
closed reduction, fracture of humerus, radius, ulna J901(sic)
closed reduction of dislocation of finger/thumb or toe J104
closed reduction of dislocation of shoulder J105 (part)
closed reduction of dislocation of elbow, wrist, knee, ankle J105 (part)

tendon repair J113A

Facio-Maxillary Surgery
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
closed reduction of fracture of maxilla/mandible J118

Other Procedures (task number not listed)
fluid management during pre- and post-op period
infection management during pre- and post-op period
first-assist in surgery
perform triage

ORAL SURGEON

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
assess fluid & electrolyte requirements B11 (part)
insert central venous line B11A
interpret electrocardiogram B16
interpret X-rays B18
perform (specialist) ENT exam B30
perform (specialist) neurological exam B31
perform (specialist) orthopedic exam B40
perform (specialist) neurosurgical exam B42
perform minor surgical procedure (including debridement of minor second degree burns, suture of lacerations, incision-and-drainage of skin and subcutaneous tissue) B57
administer core rewarming procedure B59

Anesthetic Procedures
induce general anesthesia H2
administer local/area anesthesia H4

General Surgery
major debridement-- requiring general anesthesia J1
delayed primary closure J3
free skin grafts to sites other than face J5
free skin grafts to face J6

Neurosurgery
craniotomy/craniectomy J7
burr holes J8

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
orbitotomy J15
removal of foreign body from eye structure J16
removal of eyeball J17
removal of foreign body from cornea or sclera J19
suture of cornea J20
scleroplasty and repair of sclera J21

Ear, Nose, and Throat Surgery
excision of external ear (complete or partial) J22
reduction of fracture of nasal bones J25
repair open wound of neck structures, whether superficial or deep J26

Thoracic Surgery
thoracocentesis (thoracic centesis) J39
chest tube insertion J40

Abdominal Surgery
exploratory laparotomy J44
debridement of abdominal wall and peritoneum J45
suture of abdominal wall (following debridement) J46

Orthopedic Surgery
debridement of compound fracture J86
application of traction and external fixation,
without manipulation for reduction J88
open reduction with internal fixation of fracture of
fibula, clavicle J92
open reduction with internal fixation of fracture of ankle J93
open reduction with internal fixation of fracture of wrist,
humerus, femur, tibia, radius, ulna J94
open reduction of fracture of hand, finger, foot, toe J941(sic)
open reduction with internal fixation of fracture of elbow,
amputation of fingers and/or thumb J97
amputation through upper arm J99
amputation of foot J100
amputation through lower leg J101
tendon repair J113A

Facio-Maxillary Surgery
repair of jaw fracture with inert substances J114
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
open reduction of fracture of malar bone, zygoma/zygomatic arch J117
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
first-assist in surgery
cosmetic lid surgery

DENTIST (EXCLUDING ORAL SURGEON)

Emergency Procedures
emergency surgical control of hemorrhage B5
intubation of airway B6
tracheostomy B7 (also see J27)
insert central venous line B11A
interpret electrocardiogram B16
interpret x-rays B18
perform (specialist) ENT exam B30
perform (specialist) oral (facillomaxillary) exam B401
perform minor surgical procedure (including debridement of
minor second degree burns, suture of lacerations,
incision-and-drainage of skin and subcutaneous tissue) B57
administer core rewarming procedure B59

Anesthetic Procedures
induce general anesthesia H2
administer local/area anesthesia H4

Ophthalmic Surgery
removal of foreign body from conjunctiva (without magnet) J14
removal of foreign body from eye structure J16
removal of foreign body from cornea or sclera J19

Ear, Nose, and Throat Surgery
reduction of fracture of nasal bones J25

Facio-Maxillary Surgery
repair of jaw fracture with inert substances J114
reduction of dislocation of jaw J115
closed reduction of fracture of malar bone, zygoma/zygomatic arch J116
open reduction of fracture of malar bone, zygoma/zygomatic arch J117
closed reduction of fracture of maxilla/mandible J118
open reduction of fracture of maxilla/mandible J119

Other Procedures (task number not listed)
first-assist in surgery

Appendix D

PENALTIES BY PATIENT CONDITION

PENALTIES - MINIMUM PENALTY FOR NO MD = 100 - MORTALITY AND RETURN TO DUTY WEIGHTS=100000

	CONDITION	MINIMUM TOTAL PENALTY	MAXIMUM TOTAL PENALTY	EXPECTED TOTAL MD TIME	MINIMUM PENALTY /MINUTE	MAXIMUM PENALTY /MINUTE	DIFFERENCE
1	CL CONCUS W/WO NONDEP FX,S	0	10100	138	0	73	73
2	CL CONCUS W/WO NONDEP FX,M	0	10100	80	0	126	126
3	CL CONTUS W/WO NONDEP FX,S	112000	150100	419	267	358	91
4	CL CONTUS W/WO NONDEP FX,M	90000	101600	356	253	285	33
5	CL CONTUS W/HEMATOMA,S	122499	190100	753	163	252	90
6	CL CONTUS W/HEMATOMA,M	100000	125100	744	134	168	34
7	CL CONTUS W/DEPRESS FX,S	110000	125100	934	118	134	16
8	CL CONTUS W/DEPRESS FX,M	100000	110100	1015	99	108	10
9	CONTUS W/OP SKULL FX,S	110000	150100	821	134	183	49
10	CONTUS W/OP SKULL FX,M	100000	110100	374	267	294	27
11	CRAN HEMOR,NON-TRAUM,S	100000	150100	234	427	641	214
12	CRAN HEMOR,NON-TRAUM,M	100000	125100	194	515	645	129
13	OP WOUND,SCALP,S	17500	103100	517	34	199	166
14	OP WOUND,SCALP,M	0	18100	83	0	218	218
15	CL FX,FACIAL NON-MANDI,S	50000	60600	347	144	175	31
16	CL FX,FACIAL NON-MANDI,M	70000	73100	204	343	358	15
17	OP WND,FACE/JAW/NECK,W/FX,S	102360	150100	732	140	205	65
18	OP WND,FACE/JAW/NECK,W/FX,M	100000	125100	730	137	171	34
19	OP WND,FACE/NECK,NO FX,S	100720	150100	528	191	284	94
20	OP WND,FACK/NECK,NO FX,M	20000	57100	567	35	101	65
21	OP/CL WND/INJ,EYE,S	100000	125100	332	301	377	76
22	OP/CL WND/INJ,EYE,M	100000	110100	363	275	303	28
23	WND,TYMP MEMBRANE,S	70000	77600	741	94	105	10
24	WND,TYMP MEMBRANE,M	0	1100	37	0	30	30
25	CL FX,SPINE,NO CORD DMG,S	100000	110100	272	368	405	37
26	CL FX,SPINE,NO CORD DMG,M	100000	103100	272	368	379	11
27	CL FX,SPINE,W/CORD DMG,S	100000	125100	547	183	229	46
28	CL FX,SPINE,W/CORD DMG,M	100000	110100	452	221	244	22
29	OP FX,SPINE,W/CORD DMG,S	107090	150100	904	118	166	48
30	OP FX,SPINE,W/CORD DMG,M	100000	125100	807	124	155	31
31	INTERVERT DISC DISORDER,S	100000	103100	436	229	236	7
32	INTERVERT DISC DISORDER,M	70000	75600	332	211	228	17
33	STR/SPRAIN,SACROILIAC,S	50000	53100	224	223	237	14
34	STR/SPRAIN,SACROILIAC,M	0	100	92	0	1	1
35	BURN,1ST DEG,HEAD/NECK,S	0	1100	75	0	15	15
36	BURN,1ST DEG,HEAD/NECK,M	0	100	15	0	7	7
37	BURN,2ND DEG,HEAD/NECK,S	20000	110100	383	52	287	235
38	BURN,2ND DEG,HEAD/NECK,M	0	18100	131	0	138	138
39	BURN,3RD DEG,HEAD/NECK,S	101720	125100	139	732	900	168
40	BURN,3RD DEG,HEAD/NECK,M	100000	110100	124	806	888	81
41	CL FX,CLAVICLE,M	100000	110100	237	422	465	43
42	OP WND,SHLDER,W/BON INJ,S	100000	150100	511	196	294	98
43	OP WND,SHLDER,W/BON INJ,M	100000	125100	491	204	255	51
44	CL FX,HUMERUS,UPPER,M	100000	103100	439	228	235	7
45	OP PEN WND,UP ARM,NO FX,S	100000	150100	366	273	410	137
46	OP PEN WND,UP ARM,NO FX,M	26100	62290	426	61	146	85

CONDITION		MINIMUM TOTAL PENALTY	MAXIMUM TOTAL PENALTY	EXPECTED TOTAL MD TIME	MINIMUM PENALTY /MINUTE	MAXIMUM PENALTY /MINUTE	DIFFERENCE
47	OP WND,UP ARM,W/FX/NRV,S	100000	150100	326	307	460	154
48	OP WND,UP ARM,W/FX/NRV,M	100000	150100	372	269	403	135
49	CL FX,RADIUS/ULNA,S	100000	110100	259	386	425	39
50	CL FX,RADIUS/ULNA,M	100000	103100	259	386	398	12
51	OP WND,FOREARM,NO OTH INJ,S	100000	150100	425	235	353	118
52	OP WND,FOREARM,NO OTH INJ,M	30000	65600	179	168	366	199
53	OP WND,FOREARM,FX/NRV/VASC,S	100000	150100	285	351	527	176
54	OP WND,FOREARM,FX/NRV/VASC,M	100000	150100	285	351	527	176
55	CL FX,HAND/FINGER,S	100000	103100	504	198	205	6
56	CL FX,HAND/FINGER,M	100000	101100	212	472	477	5
57	OP WND,HAND/FINGER,NO FX,S	100000	125100	476	210	263	53
58	OP WND,HAND/FINGER,NO FX,M	40000	59100	194	206	305	98
59	OP WND,HAND/FINGER,W/FX,S	100000	125100	493	203	254	51
60	OP WND,HAND/FINGER,W/FX,M	100000	125100	475	211	263	53
62	CRUSH INJ,UPPER LMB,M	100000	125100	365	274	343	69
63	CL DISLOC,SHLDR,S	10000	26600	196	51	136	85
64	CL DISLOC,SHLDR,M	0	16100	89	0	181	181
65	CL DISLOC/FX,ELBOW,S	100000	103100	294	340	351	11
68	CL DISLOC,HAND/WRST/FING,M	0	18100	109	0	166	166
69	CMPLT AMPUT,HAND,TRAUM,S	100000	175100	402	249	436	187
70	CMPLT AMPUT,FOREARM,TRAUM,S	100000	190100	243	412	782	371
71	CMPLT AMPUT,FULL ARM,TRAUM,S	100210	190100	382	262	498	235
72	CL SPRAIN,WRIST,M	0	100	95	0	1	1
73	CL SPRAIN,FINGER/THUMB,S	0	1100	109	0	10	10
74	CL SPRAIN,FINGER/THUMB,M	0	100	32	0	3	3
75	BURN,1ST DEG,UPPER LMB,S	0	100	40	0	3	3
76	BURN,1ST DEG,UPPER LMB,M	0	100	45	0	2	2
77	BURN,2ND DEG,UPPER LMB,S	100000	110100	296	338	372	34
78	BURN,2ND DEG,UPPER LMB,M	0	16100	162	0	99	99
79	BURN,3RD DEG,UPPER LMB,S	100120	125100	167	600	749	150
80	BURN,3RD DEG,UPPER LMB,M	56000	72700	729	77	100	23
81	CL FX,RIBS,S	80000	86100	144	556	598	42
82	CL FX,RIBS,M	90000	91100	115	783	792	10
84	CL INJ,LUNG,W/PNEUMOHEMO,M	100000	110100	343	292	321	29
85	OP WND,THORAX,S	100000	175100	474	211	369	158
86	OP WND,THORAX,M	0	150100	140	0	1072	1072
87	OP WND,THORAX,W/FX/PNEUM,S	102840	190100	447	230	425	195
88	OP WND,THORAX,W/FX/PNEUM,M	100000	175100	621	161	282	121
89	OP WND,HEART,S	110660	190100	762	145	249	104
90	BURN,1ST DEG,TRUNK,S	0	100	32	0	3	3
91	BURN,1ST DEG,TRUNK,M	0	100	15	0	7	7
92	BURN,2ND DEG,TRUNK,S	102600	110100	286	359	385	26
93	BURN,2ND DEG,TRUNK,M	71111	78544	330	215	238	23
94	BURN,3RD DEG,TRUNK,S	105000	125100	175	600	715	115
95	BURN,3RD DEG,TRUNK,M	100000	110100	230	435	479	44
96	WND,ABDOM WALL,NO ENTRY,S	100000	110100	457	219	241	22
97	WND,ABDOM WALL,NO ENTRY,M	0	18100	100	0	181	181
98	CL WND,LIVER,S	102360	125100	631	162	198	36
99	CL WND,LIVER,M	100000	110100	375	267	294	27
100	CL WND,SPLEEN,S	102360	125100	381	269	328	60

	CONDITION	MINIMUM TOTAL PENALTY	MAXIMUM TOTAL PENALTY	EXPECTED TOTAL MD TIME	MINIMUM PENALTY /MINUTE	MAXIMUM PENALTY /MINUTE	DIFFERENCE
101	OP WND,ABDOM,W/WND INTEST,S	111060	190100	413	269	460	191
102	OP WND,ABDOM,W/WND INTEST,M	100000	175100	440	227	398	171
103	OP WND,ABDOM,W/WND LIVER,S	110290	190100	602	183	316	133
104	OP WND,ABDOM,W/WND LIVER,M	100000	175100	375	267	467	200
105	OP WND,ABDOM,W/WND SPLEEN,S	117030	175100	409	286	428	142
106	OP WND,ABDOM,W/WND KIDNEY,S	110570	190100	447	247	425	178
107	OP WND,ABDOM,W/WND KIDNEY,M	100000	175100	458	218	382	164
108	OP WND,ABDOM,W/WND BLADDER,S	107020	190100	436	245	436	191
109	OP WND,ABDOM,W/WND BLADDER,M	100000	175100	537	186	326	140
110	OP WND,BUTTOCKS,S	100000	150100	535	187	281	94
111	OP WND,BUTTOCKS,M	0	40100	145	0	277	277
112	CL FX,PELVIS,W/TISSUE DMG,S	100000	125100	701	143	178	36
113	CL FX,PELVIS,W/TISSUE DMG,M	100000	110100	219	457	503	46
116	WND,EXTRN MALE GENIT,S	100000	125100	293	341	427	86
117	WND,EXTRN MALE GENIT,M	0	25100	110	0	228	228
118	WND,EXTRN FEMALE GENIT,S	50000	125100	498	100	251	151
119	WND,EXTRN FEMALE GENIT,M	0	25100	75	0	335	335
120	CL FX,FEMUR SHAFT,S	103045	125100	379	272	330	58
121	OP WND,THIGH,NO FX/NV/VSC,S	100000	125100	468	214	267	54
122	OP WND,THIGH,NO FX/NV/VSC,M	0	25100	125	0	201	201
123	OP WND,THIGH,W FX/NV/VSC,S	102000	150100	391	261	384	123
124	OP WND,THIGH,W FX.NV/VSC,M	100000	125100	432	231	290	58
125	OP WND,KNEE,W JNT PENETR,S	100000	150100	372	269	403	135
126	OP WND,KNEE,W JNT PENETR,M	100000	125100	486	206	257	52
127	CL FX,TIB/FIB SHAFT,S	100000	110100	346	289	318	29
128	OP WND,LOW LEG,NO FX,S	100000	150100	448	223	335	112
129	OP WND,LOW LEG,NO FX,M	55556	87322	204	272	428	156
130	OP WND,LOW LEG,W FX/NV/VSC,S	100000	175100	383	261	457	196
131	OP WND,LOW LEG,W FX/NV/VSC,M	100000	150100	392	255	383	128
132	CL FX,ANKLE/FOOT,S	100000	103100	326	307	316	10
133	CL FX,ANKLE/FOOT,M	100000	103100	369	271	279	8
134	OP WND,ANK/FT/TOE,NO FX,S	100000	150100	440	227	341	114
135	OP WND,ANK/FT/TOE,NO FX,M	11111	49544	173	64	286	222
136	OP WND,ANK/FT/TOE,W FX/N/V,S	100000	150100	376	266	399	133
137	OP WND,ANK/FT/TOE,W FX/N/V,M	100000	125100	312	321	401	80
138	CRUSH INJ,LOW LIMB,S	100000	125100	395	253	317	64
139	CRUSH INJ,LOW LIMB,M	100000	110100	372	269	296	27
140	CL DISLOC,HIP,S	100000	103100	359	279	287	9
141	TEAR,KNEE LIGAMENT,S	100000	103100	151	662	683	21
142	TEAR,KNEE LIGAMENTS,M	55222	65044	382	145	170	26
143	CL DISLOC,TOE,M	66670	67770	643	104	105	2
144	CMPLT AMPUT,FOOT,TRAUM,S	100000	175100	402	249	436	187
145	CMPLT AMPUT,LOW LEG,TRAUM,S	100000	190100	402	249	473	224
146	CMPLT AMPUT,ABV KNEE,TRAUM,S	104070	190100	685	152	278	126
147	CMPLT AMPUT,ABV KNEE,TRAUM,M	104070	190100	393	265	484	219
148	CL SPRAIN,ANKLE,S	100000	103100	176	568	586	18
149	CL SPRAIN,ANKLE,M	64286	64386	165	390	390	1
150	BURN,1ST DEG,LOW LMB/GENIT,S	0	100	55	0	2	2
151	BURN,1ST DEG,LOW LMB/GENIT,M	0	100	50	0	2	2
152	BURN,2ND DEG,LOW LMB/GENIT,S	100000	110100	291	344	378	35

CONDITION		MINIMUM TOTAL PENALTY	MAXIMUM TOTAL PENALTY	EXPECTED TOTAL MD TIME	MINIMUM PENALTY /MINUTE	MAXIMUM PENALTY /MINUTE	DIFFERENCE
153	BURN,2ND DEG,LOW LMB/GENIT,M	60000	69100	238	252	290	38
154	BURN,3RD DEG,LOW LMB/GENIT,S	100860	125100	157	642	797	154
155	BURN,3RD DEG,LOW LMB/GENIT,M	100000	110100	293	341	376	34
156	BLISTERS,HND/FING/FT/TOE,M	0	100	74	0	1	1
158	BITES/STINGS,M	0	100	30	0	3	3
159	MFW,BRAIN/CHST,W SUCKG CHST	111120	190100	827	134	230	96
160	MFW,BRAIN/ABD,W WND COLON	115913	190100	748	155	254	99
161	MFW,BRAIN/ABD,W WND KIDNEY	115420	190100	822	140	231	91
162	MFW,BRAIN/ABD,W WND BLADDER	113210	190100	794	143	239	97
163	MFW,BRN/ABD,SHOCK,WND SPLEEN	109850	199100	750	146	265	119
164	MFW,BRN/ABD,SHOCK,WND LIVER	115140	199100	724	159	275	116
165	MFW,BRAIN/L LMB,W BILAT AMPUT	111730	199100	774	144	257	113
166	MFW,CHST/ABD,W PNEU/WND COLN	112479	190100	496	227	383	156
167	MFW,CHST/ABD,W PNEU/WND KIDN	111990	190100	456	246	417	171
168	MFW,CHST/ABD,W PNEU/WND BLAD	108440	190100	459	236	414	178
169	MFW,CHST/ABD,W PNEU/WND SPLE	118550	190100	527	225	361	136
170	MFW,CHST/ABD,W PNEU/WND LIVR	111710	190100	722	155	263	109
171	MFW,CHST/LMB,W PNEU/FX/VASC	104460	190100	532	196	357	161
172	MFW,ABD,W WND COLON/BLADDER	114570	190100	541	212	351	140
173	MFW,ABD,W WND COLON/SPLEEN	122560	190100	503	244	378	134
174	MFW,ABD,W WND COLON/LIVER	116210	190100	693	168	274	107
175	MFW,ABD/LMB,W COLN/OP FX/NV	113580	190100	713	159	267	107
176	MFW,ABD/PELV,WND KIDN/LIVER	115720	190100	718	161	265	104
177	MFW,ABD/PELVIS,WND SPLE/BLAD	120540	190100	495	244	384	141
178	MFW,ABD/PLVS/LMB,FX/NV/KIDN	112090	190100	596	188	319	131
179	MFW,ABD/PLV/LMB,BLA,NO FX/NV	108020	190100	575	188	331	143
180	MFW,ABD/LMB,W FX/NV/DMG SPLE	118550	190100	474	250	401	151
181	MFW,ABD/LMB,DMG LIV,NO FX/NV	111290	190100	671	166	283	117
182	MFW,CHEST/LIMBS/BRAIN	111719	190100	806	139	236	97
183	MFW,CHST/UP LMB/ABD,WND COLN	112480	190100	571	197	333	136
184	MFW,ABD/CHST/PLVS,COLN/BLAD	135990	190100	546	249	348	99
185	MFW,ABD/CHST,MULT ORGAN DMG	134920	190100	545	248	349	101
186	MFW,NON-PERF,SKIN/SOFT TISS	100000	125100	445	225	281	56
187	TRENCH FOOT/IMMERSION FOOT,S	100000	125100	450	222	278	56
188	TRENCH FOOT/IMMERSION FOOT,M	80000	103100	404	198	255	57
190	FROSTBITE,3RD-4TH DEG	100000	110100	750	133	147	13
191	FROSTBITE,1ST-2ND DEG	100000	103100	750	133	137	4
192	HYPOTHERMIA,S	10000	29350	909	11	32	21
194	HEAT EXHAUSTION	5000	29350	40	125	734	609
195	HEAT CRAMPS,M	0	1100	26	0	42	42
199	INGUINAL HERNIA,INDIRECT(M)	100000	101100	418	239	242	3
200	INTRNL DERNGMT,KNEE,CHRONIC	77778	84211	368	211	229	17
201	STRAIN,LUMBOSAC/SACROIL JNT	20000	21100	119	168	177	9
204	BOIL/FURUNC/PYODERM,W SURG(S)	0	25100	105	0	239	239
205	BOIL/FURUNC/PYODERM,NO SRG(M)	0	100	32	0	3	3
206	CELLULITIS,FACE/WGT-BEAR(S)	0	25100	143	0	176	176
207	CELLULITIS,OTHER AREAS(M)	0	18100	71	0	255	255
208	DERMATOPHYTOSIS,CHR OR FOOT(S)	0	1100	71	0	15	15
209	DERMATOPHYTOSIS,OTHER(M)	0	100	53	0	2	2
210	PEDICULOSIS,M	0	100	15	0	7	7

CONDITION		MINIMUM TOTAL PENALTY	MAXIMUM TOTAL PENALTY	EXPECTED TOTAL MD TIME	MINIMUM PENALTY /MINUTE	MAXIMUM PENALTY /MINUTE	DIFFERENCE
211	SCABIES,M	0	15100	28	0	539	539
212	PILONIDAL CYST/ABSC,EXCIS(S)	100000	103100	447	224	231	7
213	PILONDIAL CYST/ABSC,INCIS(M)	0	18100	376	0	48	48
215	INGROWN TOENL,UNILATERAL(M)	0	100	136	0	1	1
219	HYPERHYDROSIS,M	0	100	57	0	2	2
220	BLEPHARITIS,M	0	16100	36	0	447	447
222	CONJUNCTIVITIS,AC/CHR UNI(M)	0	16100	75	0	215	215
223	CORNEAL ULCER (S)	20000	110100	150	133	734	601
224	CORNEAL ABRASION(M)	0	25100	85	0	295	295
228	REPLACE GLASSES(M)	0	100	20	0	5	5
229	OTITIS EXTERNA,M	0	100	80	0	1	1
230	OTITIS MEDIA,ACUTE,M	0	18100	57	0	318	318
232	ALLERGIC RHINITIS,M	0	100	27	0	4	4
233	URI,INCL STREP,M	0	100	36	0	3	3
234	BRONCHITIS,ACUTE,M	0	3100	55	0	56	56
236	ASTHMA,MODERATE(M)	45000	56350	130	346	433	87
237	FLU,DISABLING W/WO PNEUM(S)	30000	43600	215	140	203	63
239	VIRAL PNEUMONIA,CMPL(S)	6600	30710	854	8	36	28
244	FOOD POIS,STAPH,LESSER(M)	0	1100	68	0	16	16
246	ENTERITIS,DIARRHEA,M	0	1100	116	0	9	9
248	GASTRITIS,M	0	1100	48	0	23	23
252	REGNL ILEITIS,LESSER(M)	100000	103100	394	254	262	8
254	HELMINTHIASIS,M	0	1100	73	0	15	15
255	MIGRAINE,M	0	18100	51	0	355	355
256	HEMORRHOIDAL DIS(S)	0	18100	115	0	157	157
257	SAPHEN VARICOSITIES(M)	0	100	95	0	1	1
258	HYPERTENSION,M	6250	23410	158	40	148	109
262	TENOSYNOVITIS,M	25750	39990	129	200	310	110
266	FEVER UNKNOWN ORIGIN,M	40000	52100	844	47	62	14
267	SYPHILIS,M	0	100	95	0	1	1
268	GONORRHEA,M	0	100	85	0	1	1
269	NON-SPEC URETHRITIS,M	0	100	85	0	1	1
270	CHANCROID,M	0	100	126	0	1	1
278	URETERIC CALCULUS,NO OBSTR(M)	0	18100	122	0	148	148
279	CYSTITIS/PROSTATITIS,ACUTE,M	0	3100	315	0	10	10
280	BALANOPOSTHITIS,M	0	3100	352	0	9	9
282	INFEC MONONUCLEOSIS,M	60000	63100	361	166	175	9
283	VIRAL HEPATITIS,M	25000	28100	681	37	41	5
286	PANCREATITIS,S	100000	125100	778	129	161	32
291	DYSFUNC UTERINE BLEED(S)	0	18100	176	0	103	103
292	DYSMENORRHEA/AMENORRHEA(M)	0	100	27	0	4	4
293	SALPINGITIS/OOPHORITIS,M	0	16100	135	0	119	119
294	CERVICITIS/ENDOCERVICITIS,M	0	100	60	0	2	2
295	VULVOVAGINITIS,M	0	100	91	0	1	1
296	INDUCED ABORTION,M	0	25100	168	0	149	149
300	PREGNANCY,UNCMPL,M	100000	103100	55	1818	1875	56
301	PSYCHOSES,S	90000	110100	735	122	150	27
302	PERSONALITY DISORDERS,M	0	16100	47	0	343	343
304	COMBAT EXHAUSTION(S)	50000	67600	160	313	423	110
305	COMBAT REACTION/NEUROS(M)	0	18100	79	0	229	229

CONDITION		MINIMUM TOTAL PENALTY	MAXIMUM TOTAL PENALTY	EXPECTED TOTAL MD TIME	MINIMUM PENALTY /MINUTE	MAXIMUM PENALTY /MINUTE	DIFFERENCE
306	ALCOHOL DEPENDENCY,M	40000	40100	223	179	180	0
307	DRUNKENNESS,M	0	100	15	0	7	7
308	DRUG DEPENDENCE/ADDICT(S)	90000	90100	255	353	353	0
309	DRUG MISUSE(M)	0	100	42	0	2	2

Appendix E

SUBSTITUTION MATRIX

(Tri-service matrix, with penalties and additions/deletions from the Physician Wartime Capability Survey)

Perform minor surgical procedure (469/B57)

Urologist	PA	Family MD	Emer MD	+Internist
0.00	0.18	0.18	0.18	0.18

+Pediatrician	+OB/GYN
0.18	0.10

Prepare summary for discharge/transfer (minor) (470/B61)

Urologist	PA	Family MD	Emer MD	+Internist
0.00	0.10	0.07	0.07	0.07

+Pediatrician	+OB/GYN
0.07	0.07

Prepare summary for discharge/transfer (major) (472/B62)

Urologist	PA	Family MD	Emer MD	+Internist
0.00	0.20	0.14	0.14	0.14

+Pediatrician	+OB/GYN
0.14	0.14

Perform physical inspection/assessment (437/B3)

Dermatolog	PA	Family MD	Emer MD	+Internist
0.00	0.23	0.18	0.21	0.18

+Pediatrician
0.09

Order and document appropriate medication/treatment (476/B54)

Dermatolog	PA	Family MD	Emer MD	+Internist
0.00	0.25	0.15	0.15	0.15

+Pediatrician
0.08

Prepare summary for discharge/transfer (minor) (478/B62)

Dermatolog	PA	Family MD	Emer MD	+Internist
0.00	0.10	0.07	0.07	0.07

+Pediatrician
0.05

Prepare summary for discharge/transfer (minor) (462/B62)

OB/GYN	PA	Family MD	Emer MD	Internist
0.00	0.10	0.07	0.07	0.07

+Pediatrician
0.07

Prepare summary for discharge/transfer (major) (463/B62)

OB/GYN	PA	Family MD	Emer MD	+Internist
0.00	0.20	0.14	0.14	0.14

+Pediatrician
0.14

Perform physical inspection/assessment (465/B3)

Urologist	PA	Family MD	Emer MD	+Internist
0.00	0.28	0.18	0.21	0.28

+Pediatrician	+OB/GYN
0.28	0.12

Assess and administer intravenous requirements (466/B11)

Urologist	Family MD	PA	Emer MD	Surgeon
0.00	0.04	0.04	0.04	0.04

+Internist	+Pediatrician
0.04	0.04

Request diagnostic study (467/B14)

Urologist	Family MD	Emer MD	PA	+Internist
0.00	0.10	0.10	0.15	0.10

+Pediatrician	+OB/GYN
0.10	0.10

Order and document appropriate medication/treatment (468/B54)

Urologist	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Prepare summary for discharge/transfer (major) (447/B62)

Gastroentr	PA	Family MD	Emer MD	*Internist
0.00	0.20	0.14	0.14	0.07

*Pediatrician
0.12

Perform physical inspection/assessment (457/B3)

OB/GYN	PA	Family MD	Emer MD	Internist
0.00	0.28	0.18	0.21	0.28

*Pediatrician
0.28

Assess and administer intravenous requirements (458/B11)

OB/GYN	Family MD	PA	Emer MD	Surgeon
0.00	0.04	0.15	0.04	0.04

*Internist	*Pediatrician
0.04	0.04

Request diagnostic study (459/B14)

OB/GYN	Family MD	Emer MD	PA	*Internist
0.00	0.10	0.10	0.15	0.10

*Pediatrician
0.10

Order and document appropriate medication/treatment (460/B54)

OB/GYN	PA	Family MD	Emer MD	*Internist
0.00	0.30	0.20	0.20	0.20

*Pediatrician
0.20

Perform minor surgical procedure (461/B57)

OB/GYN	PA	Family MD	Emer MD	*Internist
0.00	0.18	0.18	0.10	0.18

*Pediatrician
0.18

Assess and administer intravenous requirements (434/B11)

Internist	Family MD	PA	Emer MD	Surgeon
0.00	0.04	0.15	0.04	0.04

+Pediatrician
0.04

Request diagnostic study (435/B14)

Internist	Family MD	Emer MD	PA	Pediatrician
0.00	0.10	0.10	0.15	0.10

Order and document appropriate medication/treatment (436/B54)

Internist	PA	Family MD	Emer MD	+Pediatrician
0.00	0.25	0.15	0.15	0.15

Prepare summary for discharge/transfer (minor) (438/B61)

Internist	PA	Family MD	Emer MD	+Pediatrician
0.00	0.10	0.07	0.07	0.07

Prepare summary for discharge/transfer (major) (439/B62)

Internist	PA	Family MD	Emer MD	+Pediatrician
0.00	0.20	0.14	0.14	0.14

Perform physical inspection/assessment (441/B3)

Gastroentr	PA	Family MD	Emer MD	+Internist
0.00	0.23	0.18	0.21	0.09

+Pediatrician
0.10

Request diagnostic study (443/B14)

Gastroentr	Family MD	Emer MD	PA	+Internist
0.00	0.10	0.10	0.15	0.05

+Pediatrician
0.10

Order and document appropriate medication/treatment (444/B54)

Gastroentr	PA	Family MD	Emer MD	+Internist
0.00	0.25	0.15	0.15	0.08

+Pediatrician
0.10

Document patient for discharge (minor) (419/B61)

PA	Family MD	Emer MD
0.10	0.00	0.00

Perform physical inspection/assessment (425/B3)

Ophthalmol	PA	Family MD	Emer MD	+Internist
0.00	0.40	0.30	0.15	0.30

+Pediatrician	+/GYN
0.30	0.30

Request diagnostic study (427/B14)

Ophthalmol	Family MD	Emer MD	PA	+Internist
0.00	0.20	0.20	0.30	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Order and document appropriate medication/treatment (428/B54)

Ophthalmol	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Prepare summary for discharge/transfer (minor) (430/B61)

Ophthalmol	PA	Family MD	Emer MD	+Internist
0.00	0.20	0.14	0.14	0.14

+Pediatrician	+OB/GYN
0.14	0.14

Prepare summary for discharge/transfer (major) (431/B62)

Ophthalmol	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Perform physical inspection/assessment (433/B3)

Internist	PA	Family MD	Emer MD	+Pediatrician
0.00	0.23	0.18	0.21	0.18

Closed reduction of dislocation of elbow, shoulder, wrist (401/J105)

Orthopedic	Surgeon	*Family MD	*Emer MD
0.00	0.11	0.21	0.08

Closed reduction of dislocation of hip (402/J106)

Orthopedic	Surgeon	*Emer MD
0.00	0.17	0.27

Open reduction of dislocation of finger/thumb or toe (404/J108)

Orthopedic	Surgeon	Emer MD
0.00	0.28	0.28

Open reduction of dislocation of wrist or elbow (405/J109)

Orthopedic	Surgeon
0.00	0.17

Closed reduction of fracture of malar bone, zygoma (412/J116)

Oral Surg	Otolaryn	Surgeon
0.00	0.05	0.38

Open reduction of fracture of malar bone, zygoma (413/J117)

Oral Surg	Otolaryn	Surgeon
0.00	0.05	0.51

Open reduction of fracture of maxilla/mandible (415/J119)

Oral Surg	Otolaryn	Surgeon
0.00	0.05	0.51

Insert central venous line (hospitals only) (417/B11A)

Family MD	Surgeon	Orthopedic	Emer MD	*Internist
0.07	0.02	0.07	0.00	0.02

*Pediatrician	*OB/GYN
0.18	0.09

Perform specialist oral (faciomaxillary) exam (428/B401)

Oral Surg	Otorphinola	*Family MD	*Emer MD	*Surgeon
0.00	0.05	0.29	0.08	0.18

Closed reduction fracture of wrist, elbow, shoulder (382/J89)

Orthopedic	Surgeon
0.00	0.20

Closed reduction fracture of ankle, tibia, femur, foot (383/J90)

Orthopedic	Surgeon
0.00	0.19

Closed reduction fracture of humerus, radius and ulna (384/J901)

Orthopedic	Surgeon
0.00	0.19

Open reduction of fracture of hand, finger, foot, toe (389/J941)

Orthopedic	Surgeon
0.00	0.42

Amputation through upper arm (394/J99)

Orthopedic	Surgeon
0.00	0.07

Amputation of foot (395/J100)

Orthopedic	Surgeon
0.00	0.03

Amputation through lower leg (396/J101)

Orthopedic	Surgeon
0.00	0.03

Amputation through upper leg (397/J102)

Orthopedic	Surgeon
0.00	0.07

Disarticulation of hip joint (398/J102)

Orthopedic	Surgeon
0.00	0.14

Closed reduction of dislocation of finger/thumb or toe (400/J104)

PA	Emer MD	Family MD	Surgeon	Orthopedic
0.15	0.00	0.15	0.05	0.00

Colostomy/ileostomy (350/J57)

Surgeon	OB/GYN	Urologist
0.00	0.50	0.50

Anastomosis, small/small to large/large to large intestine (351/J58)

Surgeon	OB/GYN	Urologist
0.00	0.46	0.46

Incision/excision/marsupialization of pilonoidal sinus (355/J62)

Surgeon	Orthopedic	Thor Surg
0.00	0.30	0.10

Nephrectomy complete, (357/J64)

Urologist	Surgeon
0.00	0.07

Repair of kidney (suture wounds) (358/J65)

Urologist	Surgeon	OB/GYN
0.00	0.08	0.53

Repair urinary bladder (361/J68)

Urologist	OB/GYN	Surgeon
0.00	0.14	0.06

Circumcision (adult) (364/J71)

Urologist	Surgeon	+OB/GYN
0.00	0.06	0.05

Repair wound open, vulva & perineum (377/J84)

Surgeon	OB/GYN
0.12	0.12

Therapeutic/demand abortion (378/J85)

OB/GYN	Family MD
0.00	0.45

Debridement of compound fracture (379/J86)

Orthopedic	Surgeon	Thor Surg
0.00	0.08	0.08

Suture & ligation of heart and pericardium (326/J34)

Surgeon	Thor Surg	Orthopedic
0.24	0.08	0.60

Anastomosis, peripheral vessels (329/J37)

Vasc Surg	Surgeon
0.00	0.15

Thoracotomy and pleurotomy (330/J38)

Thor Surg	Surgeon	Orthopedic
0.00	0.12	0.48

Insertion of chest tube (332/J40)

PA	Emer MD	Surgeon	Thor Surg	+Family MD
0.15	0.00	0.05	0.00	0.22

+Internist	+Pediatrician
0.13	0.14

Repair of inguinal hernia (335/J43)

Surgeon	+OB/GYN
0.00	0.33

Excision, lesion of abdominal wall & peritoneum (337/J45)

Surgeon	OB/GYN	Urologist
0.00	0.05	0.05

Resection of liver (341/J49)

Surgeon	Thor Surg	Urologist	-OB/GYN
0.13	0.18	0.74	0.74

Other operations on liver (342/J49)

Surgeon	Thor Surg	Urologist	-OB/GYN
0.13	0.18	0.74	0.74

Splenectomy (345/J52)

Surgeon	Thor Surg	Urologist	-OB/GYN
0.00	0.05	0.33	0.65

Delayed primary closure (293/J3)

Surgeon	Thor Surg	Orthopedic	OB/GYN	+Family MD
0.00	0.00	0.06	0.06	0.32

Free skin grafts to other sites (not face) (295/J5)

Surgeon	Orthopedic	Plas Surg
0.00	0.17	0.00

Escharotomy without general anesthetic (297/J6A)

Surgeon	Orthopedic	Family MD	+OB/GYN
0.00	0.12	0.45	0.15

Craniotomy/craniectomy (298/J7)

Neurosurg	Surgeon	Orthopedic
0.00	0.48	0.24

Burr holes (299/J8)

Neurosurg	Surgeon	Orthopedic	+Emer MD
0.00	0.25	0.13	0.27

Laminectomy with debridement and repair of spinal cord, (301/J10)

Neurosurg	-Surgeon
0.00	0.67

Removal of foreign body from eye structures (307/J16)

Ophthalmol	-Surgeon
0.00	0.57

Removal of eyeball (308/J17)

Ophthalmol	-Surgeon
0.00	0.53

Atympanoplasty (315/J23)

Otolaryn
0.00

Repair wound, neck structures, open, superficial, deep (318/J26)

Surgeon	Otolaryn	Thor Surg
0.03	0.06	0.09

Order & document appropriate medication/treatment (92/B54)

PA	Family MD	Emer MD	+Internist	+Pediatrician
0.15	0.05	0.00	0.05	0.05

+OB/GYN
0.08

Perform minor surgical procedure (95/B57)

PA	Family MD	Emer MD	Internist	+Pediatrician
0.09	0.09	0.05	0.09	0.08

+OB/GYN
0.05

Perform rapid rewarm procedure (hospitals only) (96/B58)

Family MD	Internist	Anesthesio	Emer MD	+Pediatrician
0.20	0.21	0.06	0.06	0.23

+OB/GYN
0.29

Administer core rewarming procedure (hospitals only) (97/B59)

Anesthesio	Thor Surg	Family MD	+Internist	+Pediatrician
0.06	0.12	0.20	0.21	0.23

+Emer MD	+OB/GYN
0.06	0.29

Evaluate cardiac response & function as core (98/B60)

Cardiolog	Thor Surg	Anesthesio	Emer MD	Family MD
0.00	0.09	0.03	0.03	0.06

+Internist	+Pediatrician
0.00	0.06

Debridement - major requiring general anesthetic (291/J1)

Surgeon	Thor Surg	Orthopedic	+OB/GYN
0.00	0.00	0.10	0.10

Removal of nail, nailbed or nailfold (292/J2)

Surgeon	Family MD
0.10	0.74

Perform specialist urological exam (64/B26)

Urologist	Surgeon	+Family MD	+Emer MD	+OB/GYN
0.00	0.18	0.29	0.20	0.18

Perform specialist dermatological exam (65/B27)

Dermatolog	Family MD	+Internist	+Pediatrician	+Emer MD
0.00	0.18	0.18	0.12	0.18

Perform specialist ENT exam (68/B30)

Otolaryn	Family MD	+Internist	+Pediatrician	+Emer MD
0.00	0.20	0.32	0.25	0.06

+Surgeon
0.16

Perform specialist psychiatric exam (70/B23)

Psychiatric	Family MD	+Internist	+Pediatrician	+Emer MD
0.00	0.18	0.33	0.42	0.15

Perform specialist general surgical exam (75/B37)

Surgeon	Thor Surg	+Family MD	+Emer MD	+OB/GYN
0.00	0.02	0.17	0.13	0.18

Perform specialist thoracic surgical exam (76B/38)

Thor Surg	Surgeon	+Family MD	+Emer MD	+OB/GYN
0.00	0.09	0.29	0.13	0.18

Perform specialist orthopedic surgical exam (78/B40)

Orthopedic	Surgeon	+Family MD	+Emer MD
0.00	0.15	0.17	0.06

Perform specialist neurosurgical exam (80/B42)

Neurosurg	Orthopedic	+Family MD	+Emer MD	+Surgeon
0.00	0.27	0.31	0.07	0.17

Perform proctoscopy (82/B44)

Gastroentr	Internist	Family MD	+Pediatrician	Emer MD
0.00	0.18	0.18	0.28	0.18

Perform endoscopy (other than proctoscopy) (85/B47)

Gastroentr	Family MD	Surgeon	Emer MD	+Internist
0.00	0.66	0.48	0.66	0.48

Perform clinical consultation/prepare report (outpatient) (51/B13)

Family MD	Emer MD	Surgeon	Internist	Orthopedic
0.10	0.05	0.08	0.08	0.10

+Pediatrician	+OB/GYN
0.10	0.10

Request diagnostic study (52/B14)

Family MD	Emer MD	PA	+Internist	+Pediatrician
0.05	0.03	0.15	0.05	0.05

+OB/GYN
0.05

Interpret electrocardiogram (54/B16)

Cardiolog	Family MD	Emer MD	Internist	+Pediatrician
0.00	0.03	0.00	0.00	0.16

+OB/GYN
0.25

Perform detailed clinical exam(inpatient) (58/B20)

PA	Family MD	Emer MD	+Internist	+Pediatrician
0.15	0.05	0.10	0.07	0.07

+OB/GYN
0.10

Perform specialist ophthalmological exam (59/B21)

Ophthalmol	+Family MD	+Internist	+Emer MD
0.00	0.31	0.31	0.09

Perform specialist internist exam (60/B22)

Internist	Family MD	Emer MD	+Pediatrician
0.00	0.18	0.21	0.10

Perform specialist gastroenterological exam (61/B23)

Gastroentr	Family MD	+Internist	+Pediatrician	+Emer MD
0.00	0.18	0.09	0.18	0.18

Perform specialist OBST/GYN exam (63/B25)

OB/GYN	Family MD	+Emer MD
0.00	0.18	0.23

APPENDIX E
PREFERRED AND SUBSTITUTE PROVIDER: MD TASKS
(With degradation percentages)

Key to Revisions Made in Clinical Data Base List
+: additions **-: deletions**

Obtain and record medical history (40/B2)

PA	Family/MD	Emer MD	**+Internist**	**+Pediatrician**
0.10	0.00	0.00	0.00	0.03

Perform Physical Inspection/Assessment (41/B3)

PA	Family MD	Emer MD	**+Internist**	**+Pediatrician**
0.10	0.05	0.00	0.05	0.08

Perform Emer MD surgical control of hemorrhage (43/B5)

PA	Family MD	Surgeon	Emer MD	**+Pediatrician**
0.12	0.18	0.00	0.07	0.31

+OB/GYN
0.09

Insure Adequate Airway (Intubation) (44/B6)

PA	Family MD	Emer MD	Surgeon	**+Internist**
0.08	0.04	0.00	0.03	0.06

+Pediatrician	**+OB/GYN**
0.06	0.06

Insure Adequate Airway (Tracheostomy) (45/B7)

Surgeon	Emer MD	Family MD	PA	**+Internist**
0.03	0.12	0.22	0.16	0.28

Pediatrician	OB/GYN
0.33	0.16

Assess and Administer intravenous requirements (49/B11)

Family MD	PA	Emer MD	Surgeon	**+Internist**
0.04	0.12	0.00	0.00	0.00

+Pediatrician	**+OB/GYN**
0.02	0.05

Perform physical inspection/assessment (481/B3)

Otolaryn	PA	Family MD	Emer MD	+Internist
0.00	0.40	0.30	0.15	0.40

+Pediatrician	+OB/GYN
0.15	0.30

Request diagnostic study (483/B14)

Otolaryn	Family MD	Emer MD	PA	+Internist
0.00	0.20	0.20	0.30	0.20

+Pediatrician	+OB/GYN
0.10	0.20

Order and document appropriage medication/treatment (484/B54)

Otolaryn	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.10	0.20

Prepare summary for discharge/transfer (major) (487/B62)

Otolaryn	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.10	0.20

Perform physical inspection/assessment (497/B3)

Psychiatric	PA	Family MD	Emer MD	+Internist
0.00	0.23	0.18	0.21	0.18

+Pediatrician
0.18

Order and document appropriate medication/treatment (500/B54)

Psychiatric	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.07

+Pediatrician
0.07

Prepare summary for discharge/transfer (minor) (502/B61)

Psychiatric	PA	Family MD	Emer MD	+Internist
0.00	0.10	0.07	0.07	0.20

+Pediatrician
0.20

Prepare summary for discharge/transfer (major) (503/B62)

Psychiatric	PA	Family MD	Emer MD	*Internist
0.00	0.20	0.14	0.14	0.14

*Pediatrician
0.14

Perform physical inspection/assessment (505/B3)

Surgeon	PA	Family MD	Emer MD	*Internist
0.00	0.28	0.18	0.21	0.28

*Pediatrician	*OB/GYN
0.28	0.18

Assess and administer intravenous requirements (506/B11)

Surgeon	Family MD	PA	Emer MD	*Internist
0.00	0.04	0.15	0.04	0.04

*Pediatrician	*OB/GYN
0.04	0.04

Request diagnostic study (507/B14)

Surgeon	Family MD	Emer MD	PA	*Internist
0.00	0.10	0.10	0.15	0.10

*Pediatrician	*OB/GYN
0.10	0.10

Order and document appropriate medication/treatment (508/B54)

Surgeon	PA	Family MD	Emer MD	*Internist
0.00	0.30	0.20	0.20	0.20

*Pediatrician	*OB/GYN
0.20	0.20

Perform minor surgical procedure (509/B57)

Surgeon	PA	Family MD	Emer MD	*Internist
0.00	0.09	0.09	0.05	0.09

*Pediatrician	*OB/GYN
0.09	0.05

Prepare summary for discharge/transfer (minor) (510/B61)

Surgeon	PA	Family MD	Emer MD	*Internist
0.00	0.10	0.07	0.07	0.07

*Pediatrician	*OB/GYN
0.07	0.07

Prepare summary for discharge/transfer (major) (511/B62)

Surgeon	PA	Family MD	Emer MD	+Internist
0.00	0.20	0.14	0.14	0.14

+Pediatrician	+OB/GYN
0.14	0.14

Perform physical inspection/assessment (513/B3)

Thor Surg	PA	Family MD	Emer MD	+Internist
0.00	0.28	0.18	0.21	0.28

+Pediatrician	+OB/GYN
0.28	0.18

Assess and administer intravenous requirements (514/B11)

Thor Surg	Family MD	PA	Emer MD	Surgeon
0.00	0.04	0.15	0.04	0.04

+Internist	+Pediatrician
0.04	0.04

Request diagnostic study (515/B14)

Thor Surg	Family MD	Emer MD	PA	+Internist
0.00	0.10	0.10	0.15	0.10

+Pediatrician	+OB/GYN
0.10	0.10

Order and document appropriate medication/treatment (516/B54)

Thor Surg	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Perform minor surgical procedure (517/B57)

Thor Surg	PA	Family MD	Emer MD	+Internist
0.00	0.18	0.18	0.10	0.18

+Pediatrician	+OB/GYN
0.18	0.10

Prepare summary for discharge/transfer (major) (519/B62)

Thor Surg	PA	Family MD	Emer MD	+Internist
0.00	0.20	0.14	0.14	0.14

+Pediatrician	+OB/GYN
0.14	0.14

Perform physical inspection/assessment (521/B3)

Orthopedic	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.30	0.15	0.30

+Pediatrician	+OB/GYN
0.30	0.15

Assess and administer intravenous requirements (522/B11)

Orthopedic	Family MD	PA	Emer MD	Surgeon
0.00	0.04	0.15	0.04	0.04

+Internist	+Pediatrician
0.04	0.04

Request diagnostic study (523/B14)

Orthopedic	Family MD	Emer MD	PA	+Internist
0.00	0.20	0.20	0.30	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Order and document appropriate medication/treatment (524/B54)

Orthopedic	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Perform minor surgical procedure (525/B57)

Orthopedic	PA	Family MD	Emer MD	+Internist
0.00				

+Pediatrician

Prepare summary for discharge/transfer (minor) (526/B62)

Orthopedic	PA	Family MD	Emer MD	+Internist
0.00	0.20	0.14	0.14	0.14

+Pediatrician	+OB/GYN
0.14	0.14

Prepare summary for discharge/transfer (major) (527/B62)

Orthopedic	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Perform physical inspection/assessment (529/B3)

Oral Surg	PA	Family MD	Emer MD	+Internist
0.00	0.40	0.30	0.15	0.30

+Pediatrician	+OB/GYN
0.30	0.30

Request diagnostic study (532/B14)

Oral Surg	Family MD	Emer MD	PA	+Internist
0.00	0.20	0.20	0.30	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Order and document appropriate medication/treatment (532/B54)

Oral Surg	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Prepare summary for discharge/transfer (major) (535/B62)

Oral Surg	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Perform physical inspection/assessment (537/B3)

Neurosurg	PA	Family MD	Emer MD	+Internist
0.00	0.40	0.30	0.15	0.30

+Pediatrician	+OB/GYN
0.30	0.30

Assess and administer intravenous requirements (538/B11)

Neurosurg	Family MD	PA	Emer MD	Surgeon
0.00	0.04	0.15	0.04	0.04

+Internist	+Pediatrician
0.04	0.04

Request diagnostic study (539/B14)

Neurosurg	Family MD	Emer MD	PA	+Internist
0.00	0.20	0.20	0.30	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Order and document appropriate medication/treatment (540/B54)

Neurosurg	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Prepare summary for discharge/transfer (major) (543/B62)

Neurosurg	PA	Family MD	Emer MD	+Internist
0.00	0.30	0.20	0.20	0.20

+Pediatrician	+OB/GYN
0.20	0.20

Periodic inspection of non-surgical patient (801/---)

PA	Family MD	Emer MD	+Internist	+Pediatrician
0.15	0.00	0.05	0.00	0.05

Pre-operative care-Ech 3, surgery performed at Ech 4 (802/---)

PA	Family MD	Emer MD	+Internist	+Pediatrician
0.22	0.12	0.12	0.04	0.12

Post-operative care-same Ech (803/---)

PA	Family MD	Emer MD	+Internist	+Pediatrician
0.22	0.12	0.12	0.04	0.12

Ech 4 post-operative care, surgery performed at Ech 3 (804/---)

PA	Family MD	Emer MD	+Internist	+Pediatrician
0.22	0.12	0.12	0.04	0.12

Perform patient history/assessment (810/---)

PA	Family MD	Emer MD	+Internist	+Pediatrician
0.10	0.05	0.00	0.05	0.08

Administer general anesthesia (811/---)

Nurse Anes	Anesthesio
0.10	0.00

Administer local/area anesthesia (812/---)

Nurse Anes	Anesthesio	+Family MD	+Internist	+Pediatrician
0.10	0.00	0.02	0.20	0.15

+Emer MD	+OB/GYN
0.20	0.02

Appendix F

STAFFING OPTIONS FOR AIR FORCE CONTINGENCY HOSPITALS

Table F.1

STAFFING OPTIONS FOR CONTINGENCY HOSPITALS, GENERAL SURGERY
(FY83 MD endstrength)

	TASK GROUP					
	1	2	3	4	5	6
Tasks	Specific surg. colostomy liver resec. splenectomy	Gen. surg. debride delayed pri. closure escharotomy Repair wound vulva, perineum	Repair neck wound	Specialty post-op follow-up Minor surg.	Exams	Other & Adminis.
% of gen. surgery requirement	19%	18%	10%	34%	6%	13%
Substitutes available	None	Ob/gyn	ENT	1. Ob/gyn Emer. med. Fam. prac. 2. Int. med. Peds.	Emer. med. Ob/gyn Fam. prac.	Fam. prac. Int. med. Peds. PA
Assignment made by model						
gen. surgeon	87%	0%	0%	1%	1%	1%
substitute	0	66	45	71	76	87
unassigned	13	34	55	28	23	12
Substitutes used in model	--	Ob/gyn	ENT	Fam. prac.	Fam. prac.	Peds.

Table F.1—continued

	TASK GROUP			
	1	2	3	4
Tasks	Reduce fractures dislocat'ns Debride compound fractures Amputation	Specialty post-op follow-up Minor surg.	Exams	Other & Adminis.
% of orthopedic requirement	28%	31%	16%	25%
Substitutes available	Gen. surg.	1. Ob/gyn Emer. med. 2. Fam prac. Int. med. Peds.	Emer. med. Gen. surg. Fam. prac.	Fam. prac. Int. med. Peds. PA
Assignment made by model				
orthopedist	44%	<1%	0%	<1%
substitute	29	66	74	66
unassigned	27	34	26	34
Substitutes used in model	Gen. surg.	Ob/gyn	Emer. med. Fam. prac.	Peds.

Table F.2

STAFFING OPTIONS FOR CONTINGENCY HOSPITALS, NEUROSURGERY
(FY83 MD endstrength)

	TASK GROUP			
	1	2	3	4
Tasks	Craniotomy/ craniectomy Laminectomy w/ spinal cord repair Burr holes	Specialty post-op follow-up	Exams	Other & Adminis.
% of neurosurgical requirement	40%	34%	13%	13%
Substitutes available	Orth. surg.	1. Emer. med. 2. Ob/gyn Fam. prac. Int. med. Peds.	1. Emer. med. 2. Orth. surg. Gen. surg. Fam. prac.	Fam. prac. Int. med. Peds. PA
Assignment made by model				
neurosurgeon	13%	0%	0%	0%
substitute	0	40	65	56
unassigned	87	60	45	44
Substitutes used in model	--	Peds.	Emer. Med.	Peds.

Table F.3

STAFFING OPTIONS FOR CONTINGENCY HOSPITALS, OPHTHALMOLOGY
(FY83 MD endstrength)

	TASK GROUP			
	1	2	3	4
Tasks	Surgery	Specialty post-op follow-up	Exams	Other & Adminis.
% of ophthalmology requirement	42%	18%	18%	42%
Substitutes available	None	1. Emer. med. 2. Ob/gyn Fam. prac. Int. med. Peds.	1. Emer. med. 2. Fam. prac. Int. med.	Fam. prac Int. med. Peds. PA
Assignment made by model				
ophthalmologist	76%	100%	62%	100%
substitute	0	0	0	0
unassigned	24	0	38	0
Substitutes used in model	None			

Table F.4

STAFFING OPTIONS FOR CONTINGENCY HOSPITALS, THORACIC SURGERY
(FY83 MD endstrength)

	TASK GROUP			
	1	2	3	4
Tasks	Surgery	Specialty post-op follow-up Minor surg.	Exams	Other & Adminis.
% of thoracic requirement	36%	39%	8%	17%
Substitutes available	Gen. surg.	Ob/gyn Emer. med. Fam. prac. Int. med. Peds.	1. Gen. surg. Emer. med. Ob/gyn 2. Fam. prac.	Fam. prac. Int. med. Peds. PA
Assignment made by model				
thoracic surgeon	20%	0%	0%	0%
substitute	64	99	99	99
unassigned	16	1	1	1
Substitutes used in model	Gen. surg.	Fam. prac.	Ob/gyn	Peds.

Table F.5

STAFFING OPTIONS FOR CONTINGENCY HOSPITALS,
VASCULAR SURGERY
(FY83 MD endstrength)

	TASK GROUP
	1
Tasks	Surgery
% of vascular requirement	100%
Substitutes available	Gen. surg.
Assignment made by model	
vascular surgeon	17%
substitute	67
unassigned	15
Substitutes used in model	Gen. surg.

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